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MARINE TRAFFIC DATA FOR THE PORT OF BOSTON.(U)
JAN 77 J A MCINTOSH, J J CHERNY, D E WATSON

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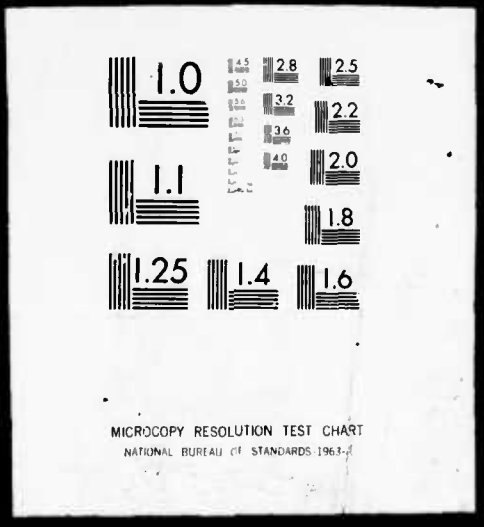

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Task No. 774501.1.1.2

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MARINE TRAFFIC DATA FOR THE PORT OF BOSTON

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FINAL REPORT

PREPARED FOR

U.S. DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
OFFICE OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20590

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16. Abstract

Data was recorded on marine traffic in the Port of Boston and on VHF-FM marine communications channel usage in the Port of Boston during the period 13 to 20 September 1976. The marine traffic data was recorded by means of time lapse photography of the display of a radar whose antenna was located at the north-eastern corner of Commonwealth Pier 6, which is at 42°21'06"N., 71°02'14"W. The radar recordings were analyzed to compile statistics on marine traffic in the area. The maximum number of simultaneous movements observed at this site was 30. This was observed on Sunday, 19 September 1976. Recordings were made of communications on VHF-FM maritime mobile channel 13 and 16 as received at the same site. These recordings were analyzed to compile statistics on communications activity. Channel 13 had about a 3 percent daily utilization rate, while channel 16 had an 8 percent rate.

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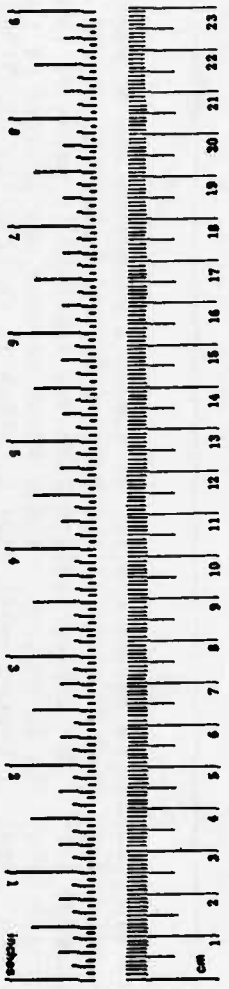
408 730 AB

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

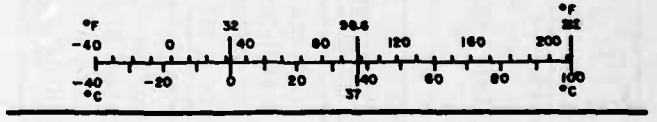
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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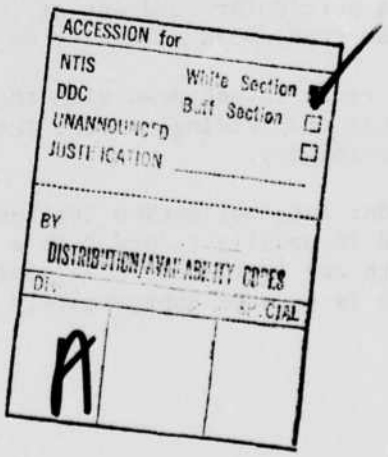
1.0 INTRODUCTION

The purpose of this report is to document the data obtained on the marine traffic in the Port of Boston by U.S. Coast Guard Research and Development Center personnel during the period 13 to 20 September 1976. The data consists of recordings of a radar display of the central area of the port, and of recordings of the activity on Channels 13 and 16 of the maritime mobile VHF-FM band. The analysis consists of the preparation of statistical summaries of the activity recorded. The details as to how the data was recorded and analyzed are presented in later sections of this report. In addition to data obtained by the Research and Development Center personnel, this report contains a statistical summary of vessel arrival and departure records prepared by the Coast Guard Marine Safety Office (MSO) in Boston. This information was included because it complements the information obtained directly from the radar and radio recordings.

The above data was obtained to establish the approximate amount of marine traffic in the Port of Boston that is subject to the Bridge-to-Bridge Radio-Telephone Act, for the purposes of determining whether or not the establishment of a Vessel Traffic Center (VTC) is warranted, and for planning a VTC, if it should be decided that one should be established. Data was collected in the Boston area as part of a larger plan to collect and analyze similar data from all U.S. harbors as well as at congested or complex portions of rivers, channels, bays or waterways. This has been done in recognition of the fact that, in recent years, the total volume of marine commerce has been increasing steadily, with the proportion of hazardous and/or polluting cargo rising sharply. Coupled with this growth in the volume and hazardous nature of the cargo has been a trend toward larger tankers and other merchant vessels. Consequently, the potential damages, given a collision or a grounding, have risen dramatically, with an attendant increase in the potential for loss of life and property and for ecological damage. In an attempt to minimize the number of marine casualties, the Coast Guard has established, or is planning to establish, Vessel Traffic Centers in areas deemed particularly congested or hazardous.



2.0 RADAR DATA COLLECTION PROCEDURES AND EQUIPMENT

The data collection radar and the associated equipment is mounted in a specially-built trailer for ease of transportation, use and protection from the elements.

The radar used for data collection is a Decca Marine Model RM429 which operates in the frequency band 9380 to 9440 MHz. The radar antenna has a horizontal beamwidth of 0.8 degrees at the -3dB points, and the radar transmitter pulse length varies from 0.05 usec. to 1.2 usec., depending on the range selected. A 16mm motion picture camera is mounted over the radar PPI (Plan Position Indication) display and focused so that the PPI presentation fills the majority of the 16mm frame area. (A hood is used to screen out ambient light.) The camera is operated in the single-frame mode, and the shutter of the camera is controlled by a solenoid. The operation of the solenoid is controlled by the radar heading flasher switch so that the shutter is held open for one complete revolution of the radar antenna, then closed during the second revolution, open again during the third revolution, and so on. As a result of this procedure, the film consists of a sequence of "snapshots" of the whole radar display, which is pleasing to the eye and is easier to interpret than a conventional motion picture.

Mounted above and below the PPI display and within the field of view of the camera are small, alpha-numeric display panels. Auxiliary circuitry is used to display the date and time and the geographic name of the radar site on these panels. As a result, each frame of the 16mm film contains the time that it was exposed and the location of the radar at that time. This information simplifies the task of determining vessel speeds or the time an observed event occurred.

The radar has the capability of orienting the PPI display in any direction. The practice has been adopted of orienting the display so that True North is at the top of the 16mm film frame, when viewed so that the alpha-numeric characters are properly oriented. However, due to various limitations, the orientation of the film image with respect to True North is probably not accurate to better than ± 5 degrees.

The radar also has the capability of offsetting the antenna location from the center of the PPI screen. This capability allows the PPI display to be arranged so that a particular quadrant of interest fills a greater portion of the 16mm film frame than would otherwise be possible.

Although the radar is equipped with the usual heading flasher, fixed and variable range rings and bearing cursor, they are usually suppressed and do not appear on the film imagery.

After the radar data collection trailer arrives at a given site, is tested and adjusted, data is usually recorded on a 24-hour-a-day basis for 7 days. A few minutes of data are lost every five hours when the camera film is changed; otherwise, a frame is exposed approximately every four seconds during the 7-day period.

3.0 SITE SELECTION AND DATA REDUCTION PROCEDURES

The purpose of this section is to discuss the procedures used to select a site for data collection and to analyze the photographic films containing the radar data. The results of the analysis are presented in the following section.

Ideally, one would like to be able to position a traffic data collection radar so as to be able to track all commercial vessels throughout the harbor. However, due to the fact that the Boston harbor area is geographically quite complex, consisting of the intersection of four rivers, with numerous large buildings near or immediately on the water's edge and a number of bridges, it was not possible to locate such a site. It was eventually decided that the single site that would provide the most (and most useful) data was the north-eastern corner of Commonwealth Pier 6, at position 42°21'06"N., 71°02'14"W. The radar antenna was about 30 feet above sea level at this site. From this site all traffic between the northeastern corner of Castle Island and the mouth of the Charles River was in view; thus all traffic entering or leaving the harbor passed through the radar coverage area. Although it was not possible to track vessels bound for the Mystic River or Chelsea River to their berths, the berths of all vessels tracked during the period that the radar was in operation were available through the Coast Guard Marine Safety Office (MSO) (also see Appendix A).

On Saturday and Sunday afternoons the density of recreational small craft was so high that it was difficult to track even the large vessels. Tugs and tugs-with-tows were included in all of the statistics whenever they were recognizable in the radar imagery.

The following information can generally be extracted from films of the type under discussion here:

Vessel arrival time/departure time
Speed
Destination (within the harbor)
Anchorage location
Time at anchor
Traffic density
Closest point of approach to other vessels
Separation distance (when following another vessel)
Number and time of occurrance of meeting situations
Number and time of occurrance of overtaking situations
Number and time of occurrance of crossing situations

The traffic flow in the area under observation was such that there were no crossing situations; due to the relatively light traffic no overtaking situations were observed, nor was there an opportunity to measure the separation distance between two vessels. In fact, only one meeting situation (between vessels judged to be subject to the Bridge-to-Bridge Radio-Telephone Act) was observed during the week that radar data was being recorded. Since an excellent study of vessel berthing destinations (within the harbor) was possible from the records maintained by MSO Boston, and since many of these berths were not within the area of radar coverage, no attempt was made to track observed vessels to their berths.

Vessel arrival and departure times were determined by noting the time on the film frame when they were at the mouth of the harbor. Speeds were determined by noting the time required for the vessel to leave two readily identifiable points abeam; (Logan Airport runway approach lights and Pier 6) the distance between these points was obtained from a nautical chart, permitting the average speed made good between these points to be computed directly. Traffic density counts were the census of vessels, of any size, imaged by the radar at a given time. As mentioned earlier, this was difficult to do on Saturday and Sunday afternoons due to the very large number of recreational craft on the water.

That portion of the harbor imaged by the radar is shown in Figure 3-1. Figure 3-2 shows a typical frame of the filmed radar data.

Route identification of Boston Harbor is indicated in Figure 3-3, the indication being for an 8-hour period on Thursday, 16 September 1976, with 12 vessels being present.

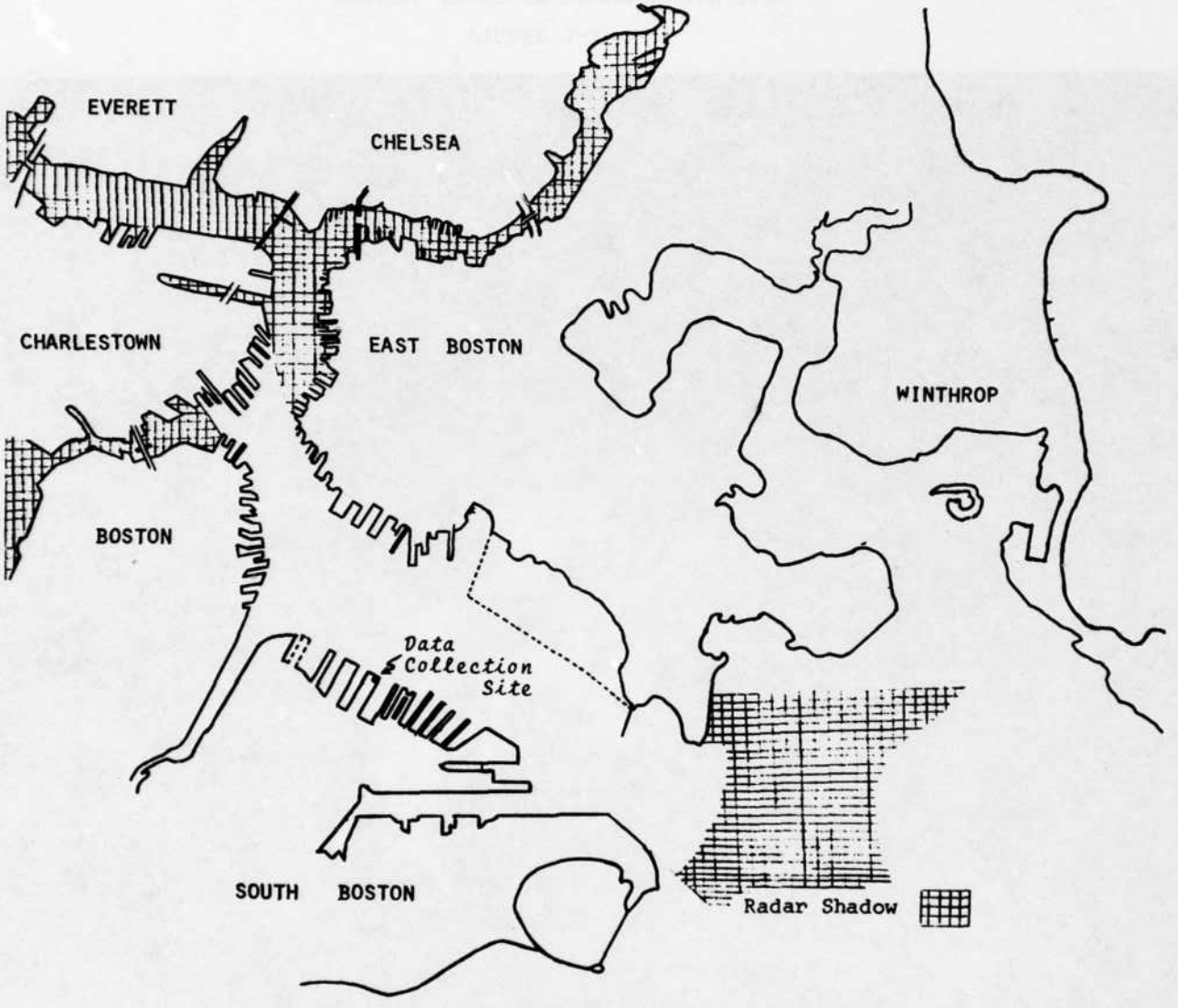


FIGURE 3-1

RADAR COVERAGE OF BOSTON HARBOR

FIGURE 3-2

TYPICAL FRAME OF FILMED RADAR DATA

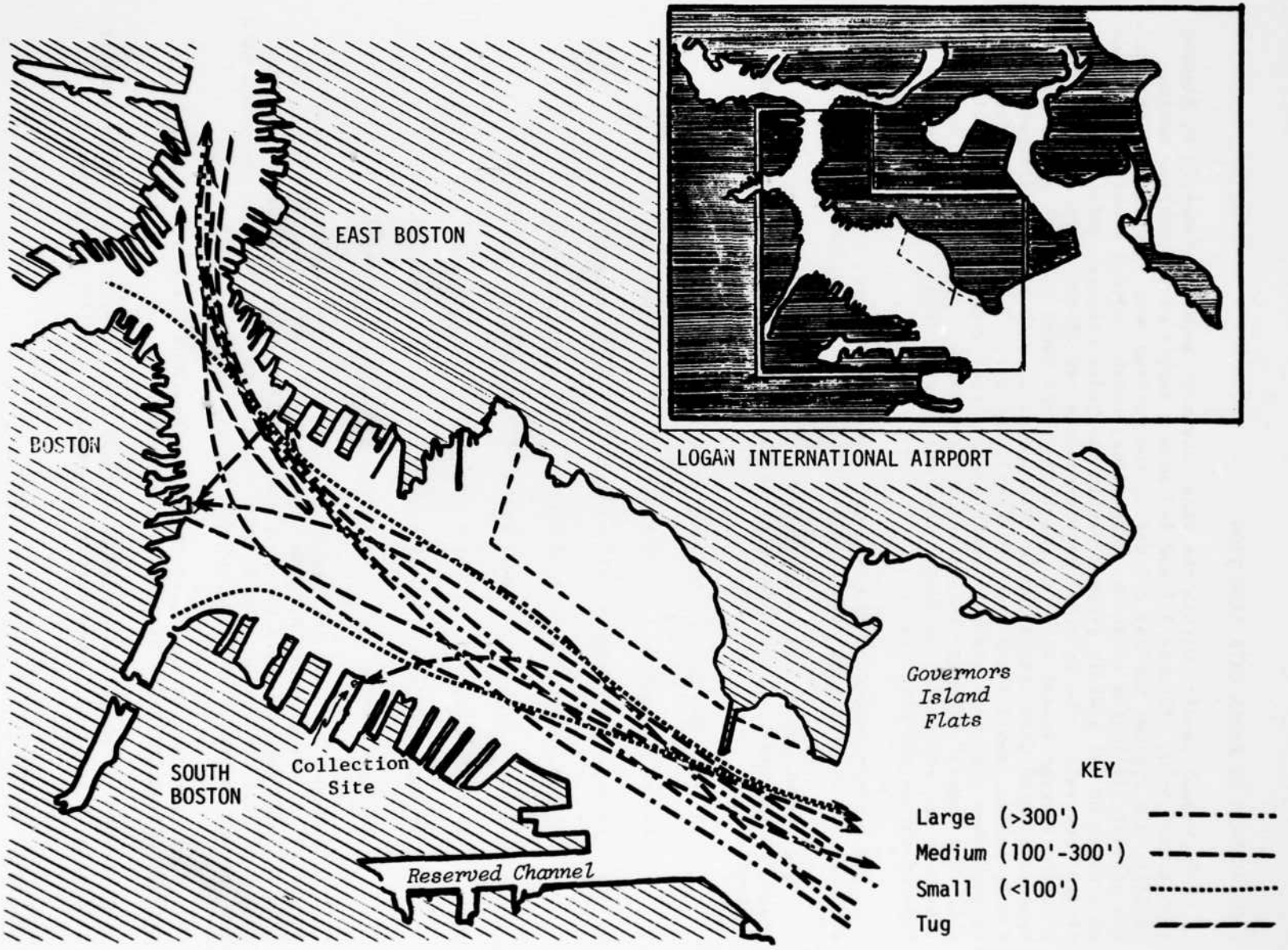


FIGURE 3-3: ROUTE IDENTIFICATION, 16 SEP 1976, 0000-0800 (EDT)

4.0 RESULTS OF RADAR DATA REDUCTION

The vessel density within the radar coverage area is presented in Figures 4-3 through 4-10. Figures 4-1 and 4-2 show a sample of the daytime marine traffic on a typical weekday and during the weekend when the greatest traffic was present, including numerous recreational boats. Vessel density is defined as a count of all vessels present within the radar coverage area, taken at 15-minute intervals. The interval between counts was chosen to be equal to or less than the average vessel transit time through the radar coverage area. The vessels counted were classified by type and size, such as large (larger than 300 feet), medium, small (less than 100 feet), tug etc. Tugs were only identifiable as such when they were observed assisting a larger vessel or observed with a tow. The "small" category includes fishing vessels, pleasure craft and tugs that were not recognized as such. The data is presented as a histogram with time of day as the abscissa.

The maximum number of simultaneous movements observed at the Boston Harbor site was 30, occurring at 1530 and 1615 on Sunday, 19 September 1976.

The vessel speed data is based on the speed of virtually all of the vessels imaged by the radar, and is presented in Figures 4-11 through 4-18. A summary follows:

13 Sep - Monday	4-30 knots	(11.6 knots average)
14 Sep - Tuesday	3-32 knots	(12.6 knots average)
15 Sep - Wednesday	2-27 knots	(10.4 knots average)
16 Sep - Thursday	3-30 knots	(11.5 knots average)
17 Sep - Friday	4-20 knots	(8.9 knots average)
18 Sep - Saturday	4-29 knots	(10.5 knots average)
19 Sep - Sunday	2-35 knots	(10.7 knots average)
20 Sep - Monday	3-18 knots	(9.4 knots average)

An encounter between two medium or large vessels was deemed a "close encounter" if the distance between them at the closest point of approach was less than 300 yards. There was only one close encounter observed during the period of data collection. No attempt was made to acquire close encounter data for the very numerous small vessel meeting situations.

There were no overtaking or crossing situations between medium or large vessels during the radar data collection period.

Figure 4-19 shows the arrival and departure activity of the large vessels utilizing the port of Boston during the radar data collection period.

FIGURE 4-1
TYPICAL FRAME OF WEEKDAY FILMED RADAR DATA

FIGURE 4-2
TYPICAL FRAME OF WEEKEND FILMED RADAR DATA

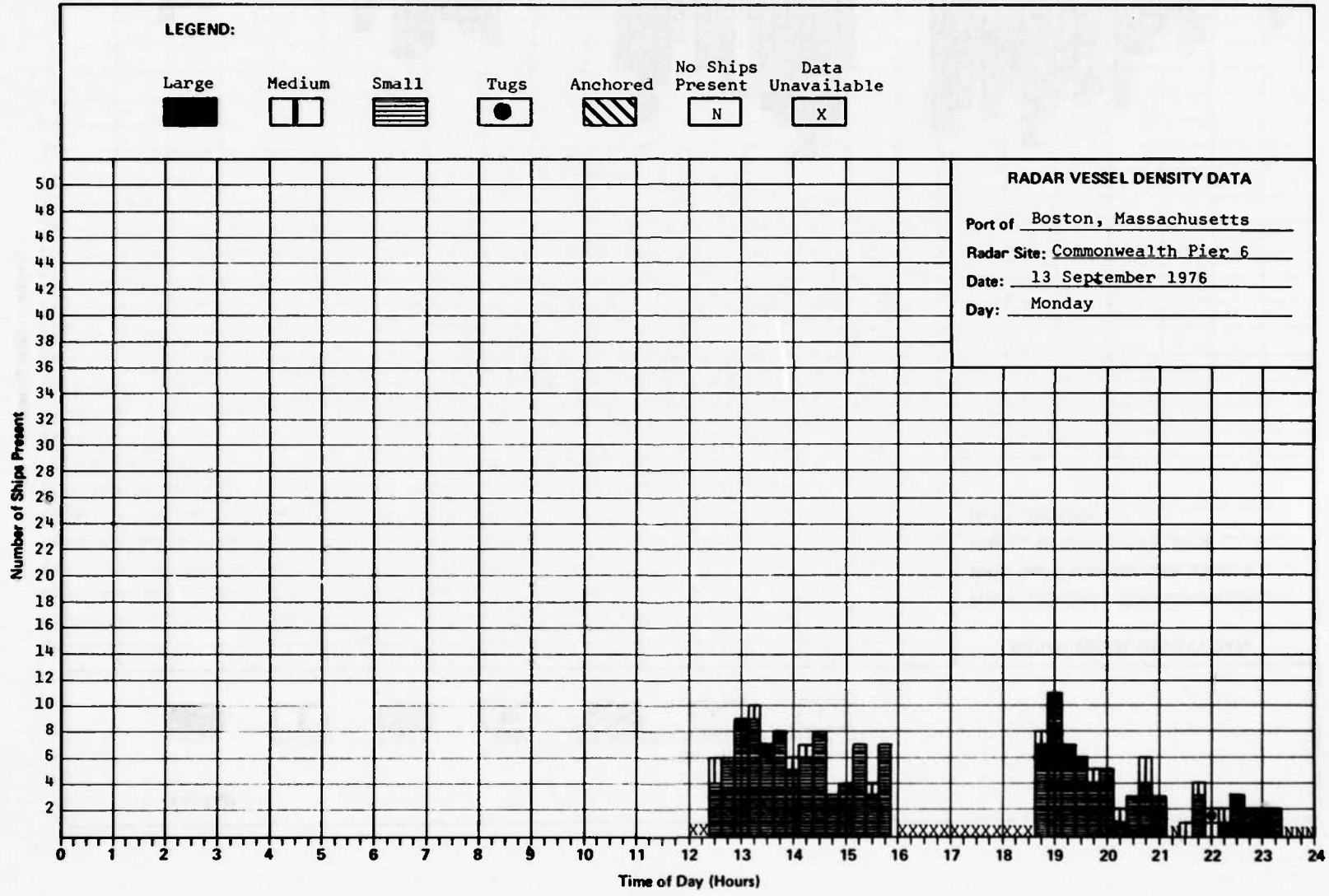

LEGEND:
Large
Medium
Small
Tugs
Anchored
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Boston, Massachusetts
Radar Site: Commonwealth Pier 6
Date: 13 September 1976
Day: Monday
Number of Ships Present
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day (Hours)

FIGURE 4-3

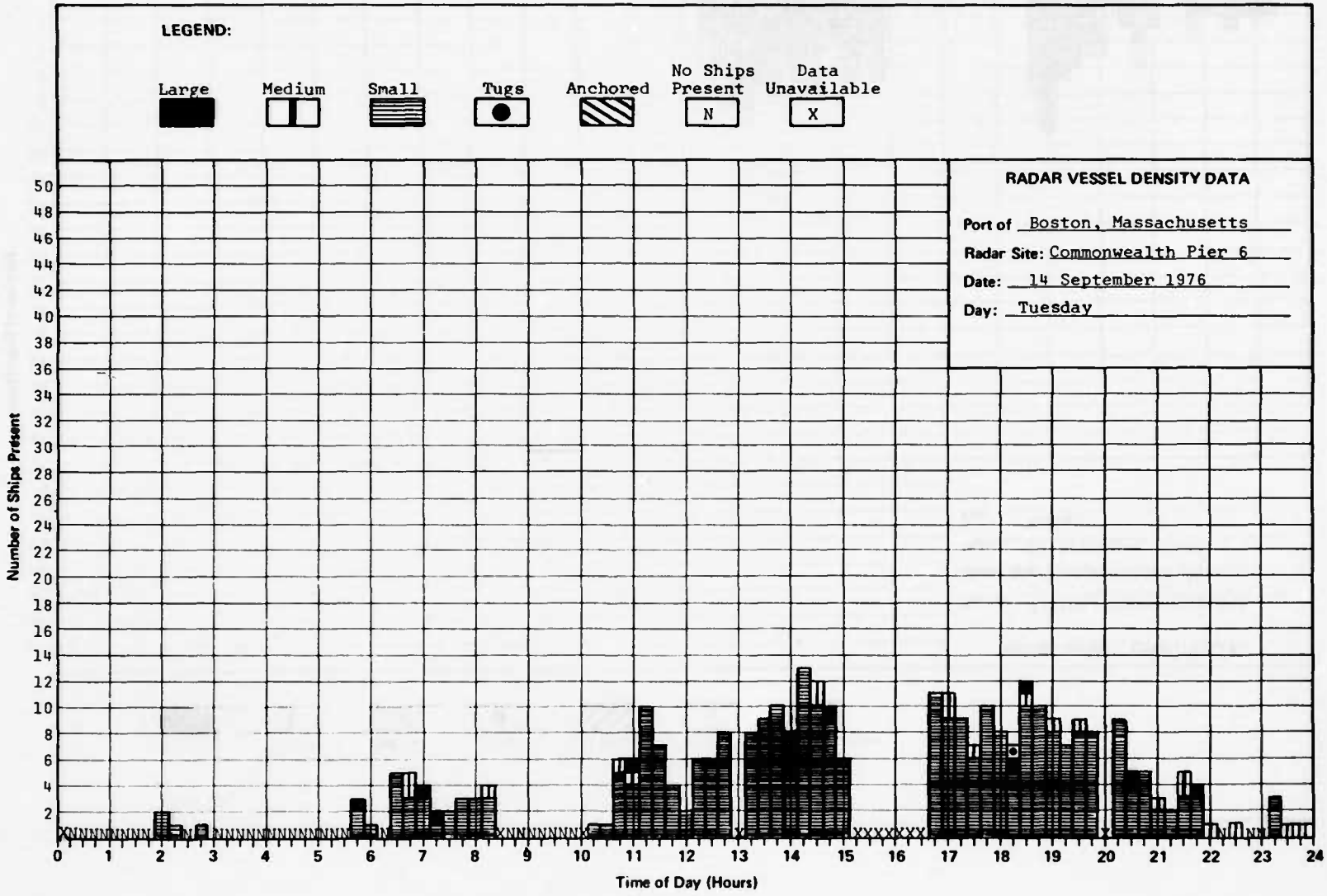

LEGEND:
Large
Medium
Small
Tugs
Anchored
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Boston, Massachusetts
Radar Site: Commonwealth Pier 6
Date: 14 September 1976
Day: Tuesday
Number of Ships Present
Time of Day (Hours)

FIGURE 4-4

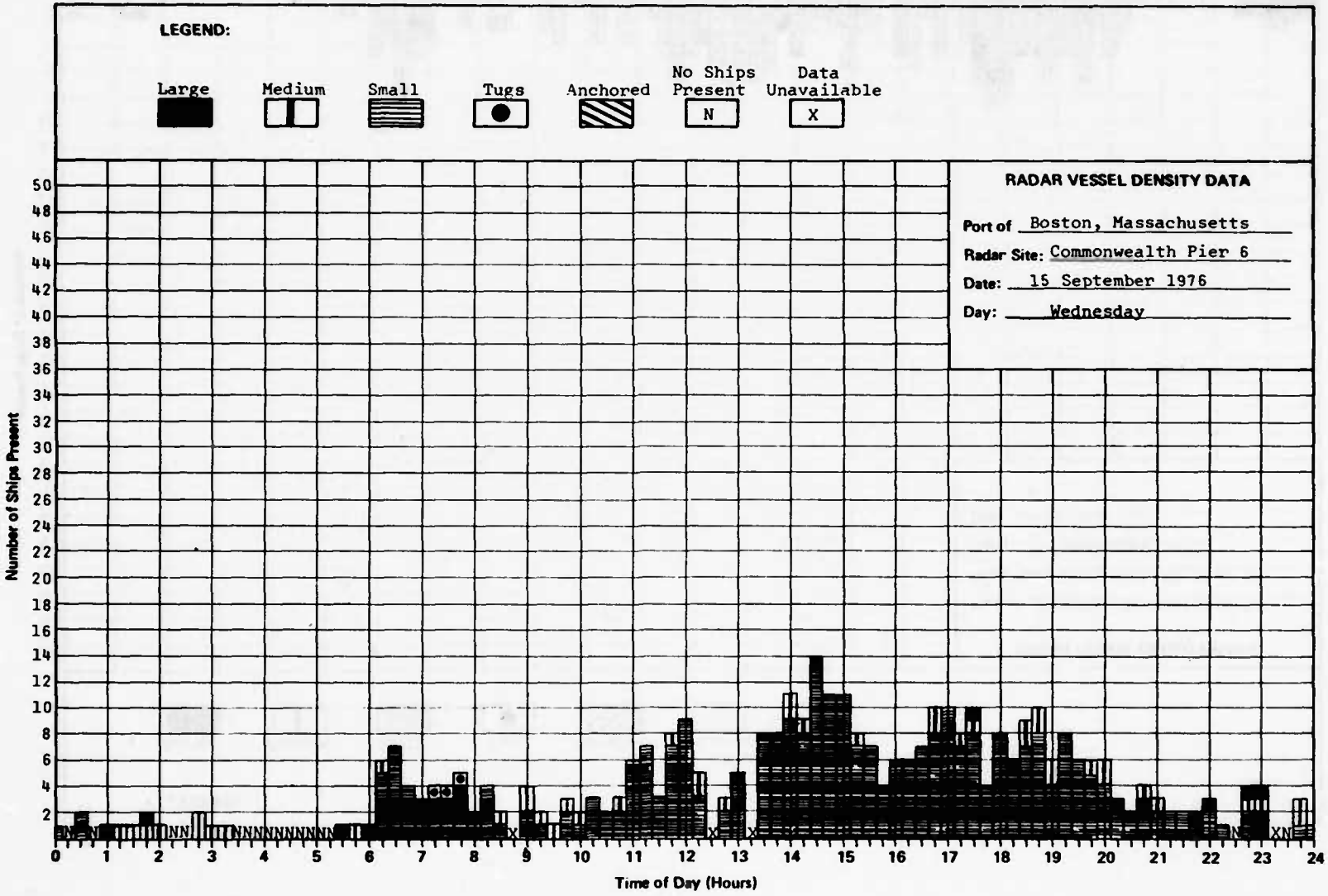

LEGEND:
Large
Medium
Small
Tugs
Anchored
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Boston, Massachusetts
Radar Site: Commonwealth Pier 6
Date: 15 September 1976
Day: Wednesday
Number of Ships Present
Time of Day (Hours)

FIGURE 4-5

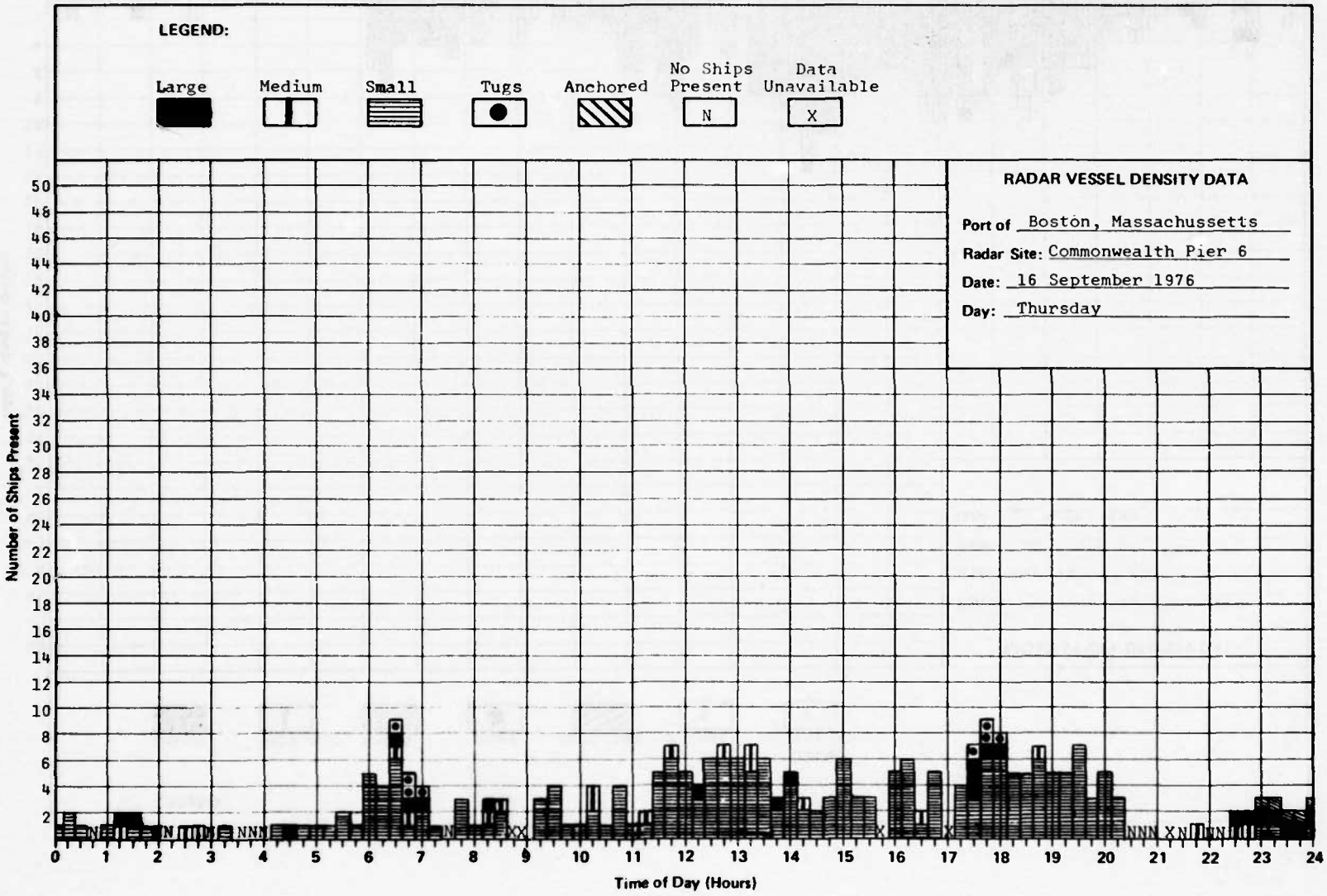

LEGEND:
Large
Medium
Small
Tugs
Anchored
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Boston, Massachussetts
Radar Site: Commonwealth Pier 6
Date: 16 September 1976
Day: Thursday
Number of Ships Present
Time of Day (Hours)

FIGURE 4-6

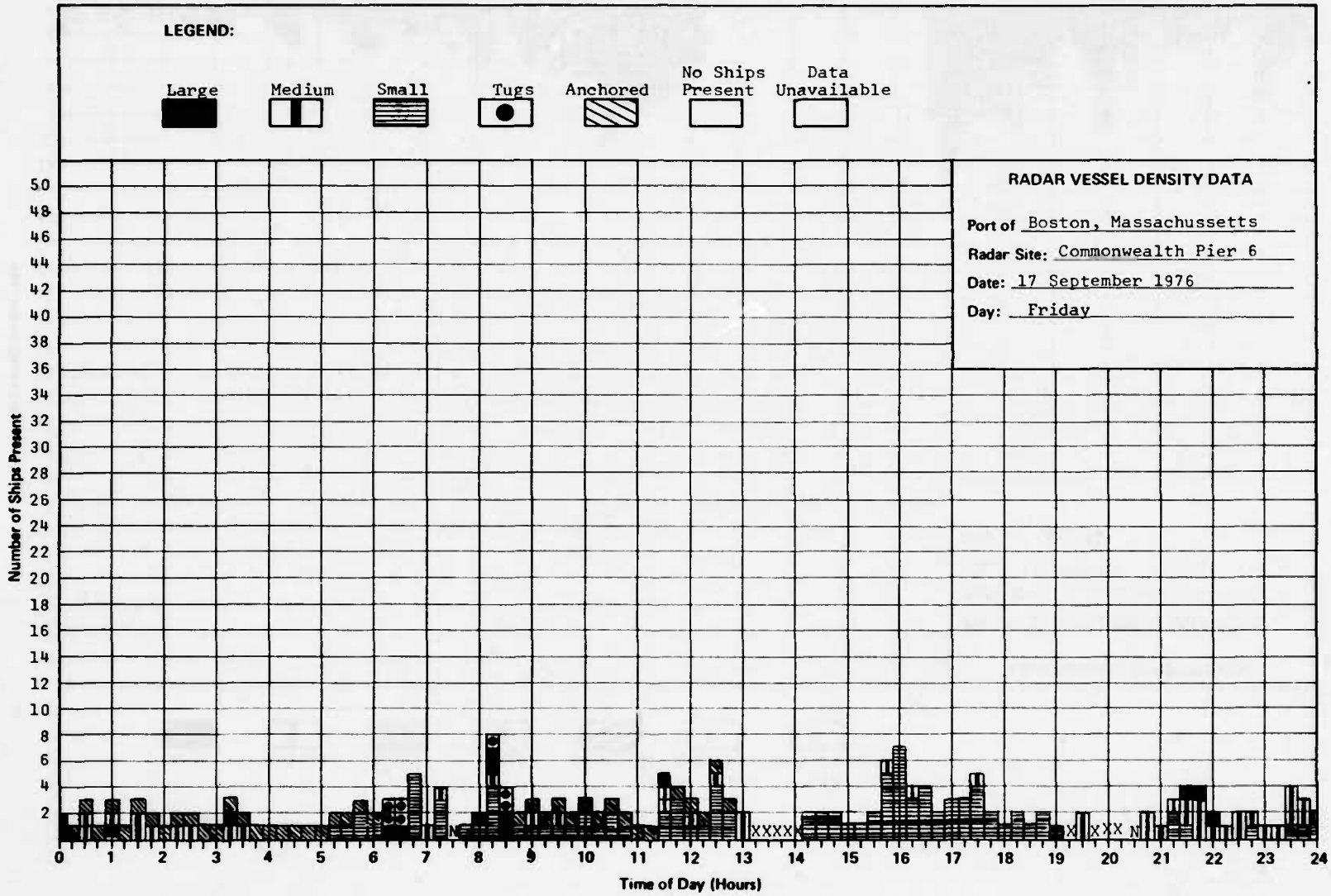

LEGEND:
Large
Medium
Small
Tugs
Anchored
No Ships Present
Data Unavailable
RADAR VESSEL DENSITY DATA
Port of Boston, Massachussetts
Radar Site: Commonwealth Pier 6
Date: 17 September 1976
Day: Friday
Number of Ships Present
Time of Day (Hours)

FIGURE 4-7

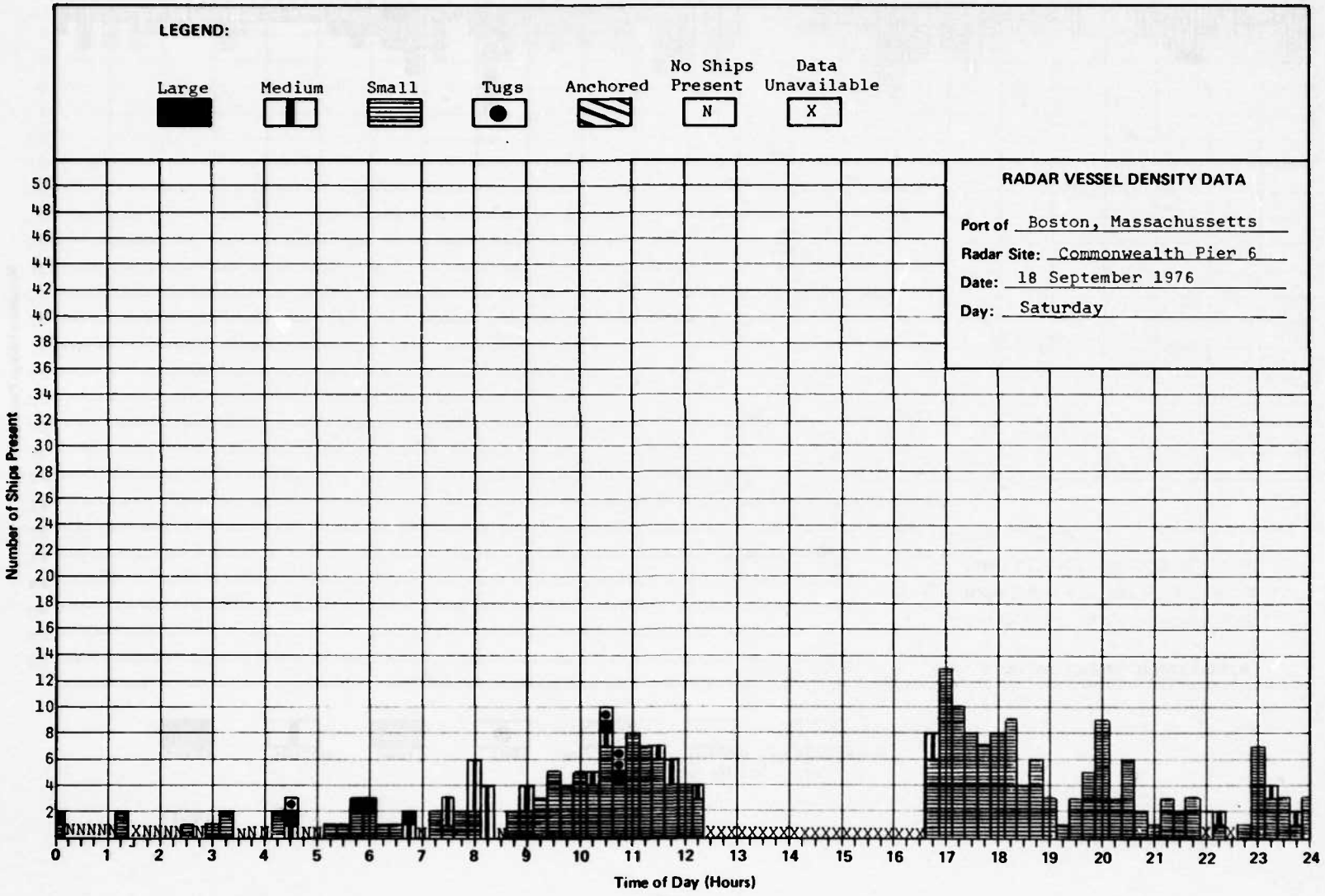

LEGEND:
Large
Medium
Small
Tugs
Anchored
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Boston, Massachussetts
Radar Site: Commonwealth Pier 6
Date: 18 September 1976
Day: Saturday
Number of Ships Present
Time of Day (Hours)

FIGURE 4-8

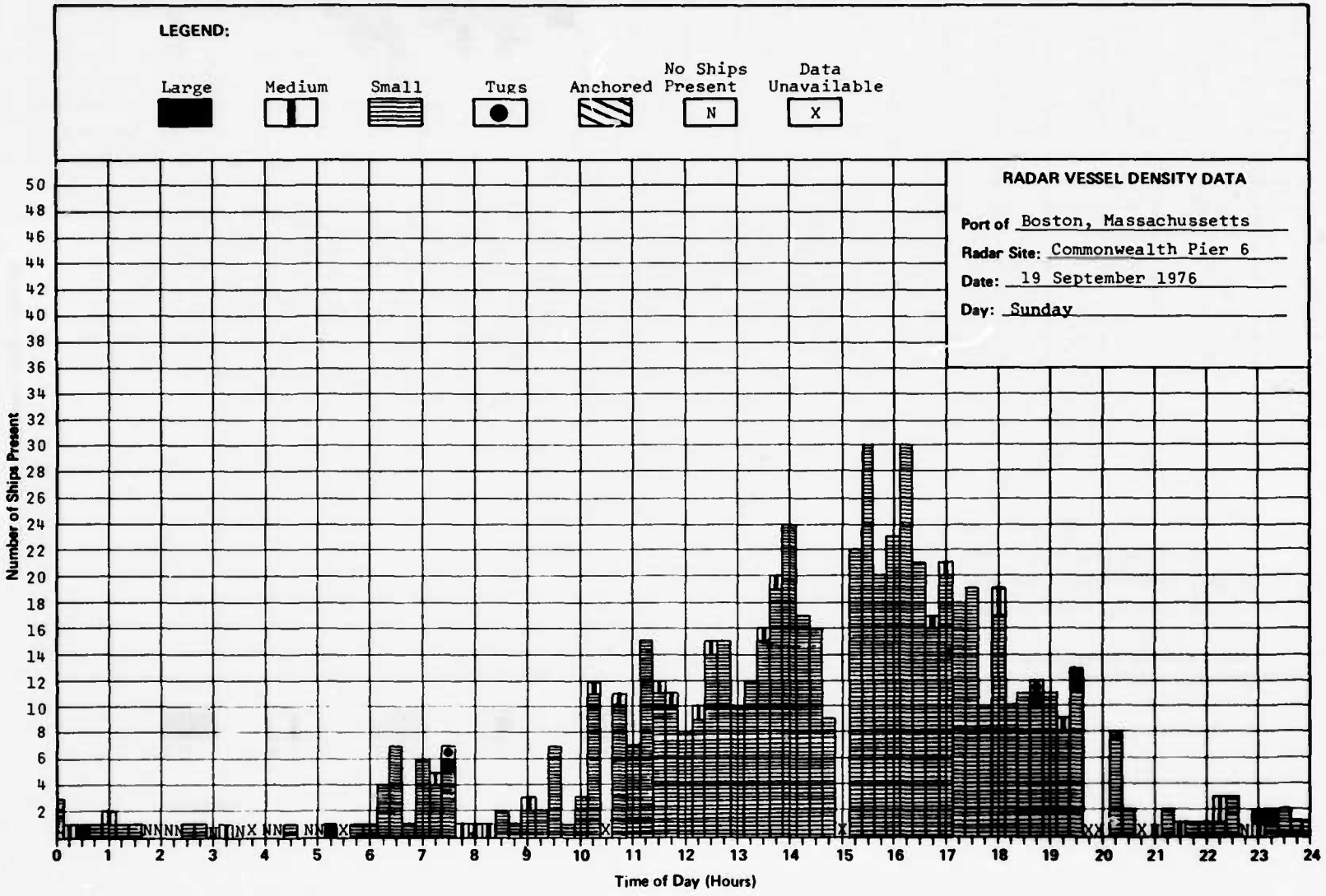

LEGEND:
Large
Medium
Small
Tugs
Anchored
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Boston, Massachussetts
Radar Site: Commonwealth Pier 6
Date: 19 September 1976
Day: Sunday
Number of Ships Present
Time of Day (Hours)

FIGURE 4-9

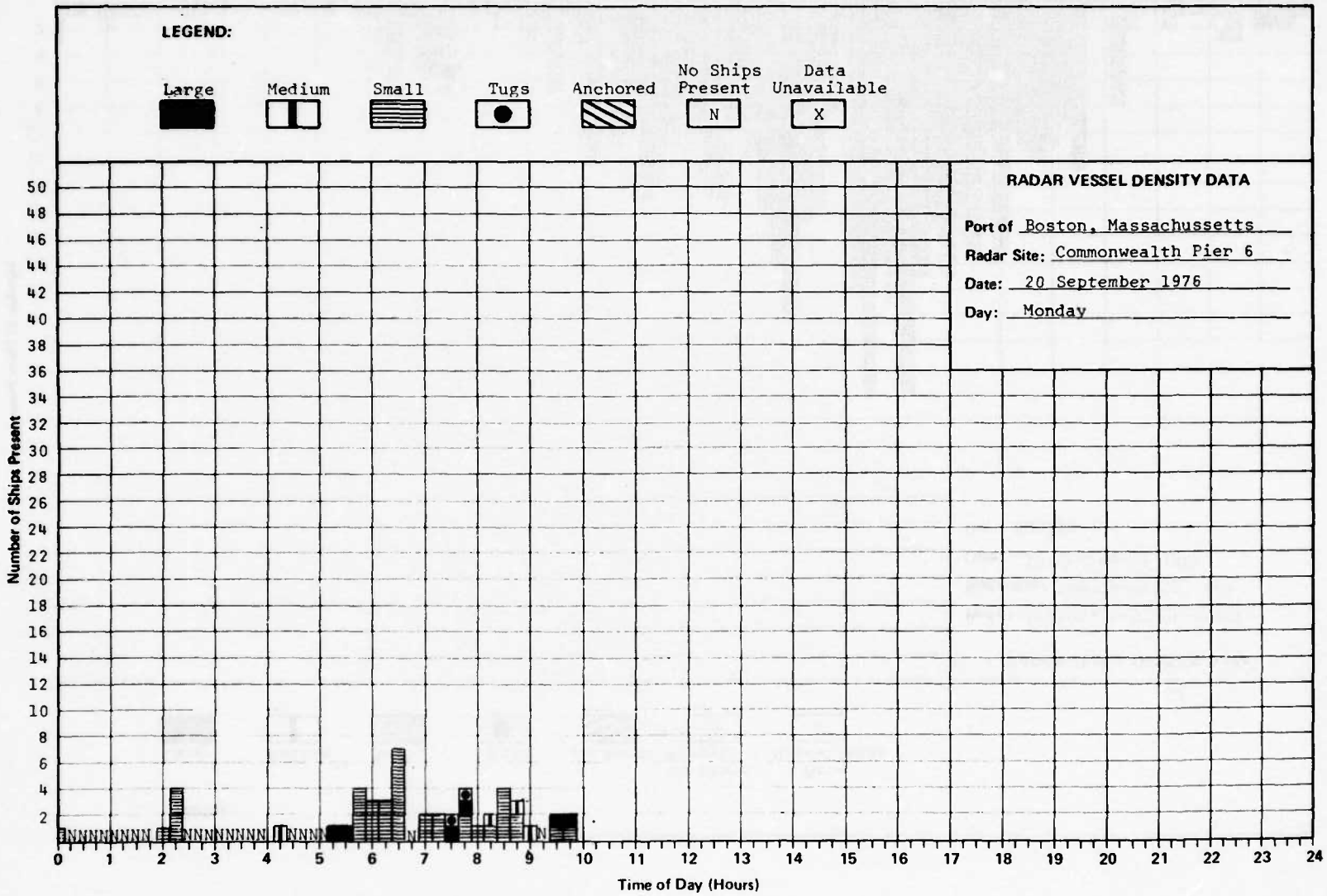

LEGEND:
Large
Medium
Small
Tugs
Anchored
No Ships Present
N
Data Unavailable
X
RADAR VESSEL DENSITY DATA
Port of Boston, Massachussetts
Radar Site: Commonwealth Pier 6
Date: 20 September 1976
Day: Monday
Number of Ships Present
Time of Day (Hours)

FIGURE 4-10

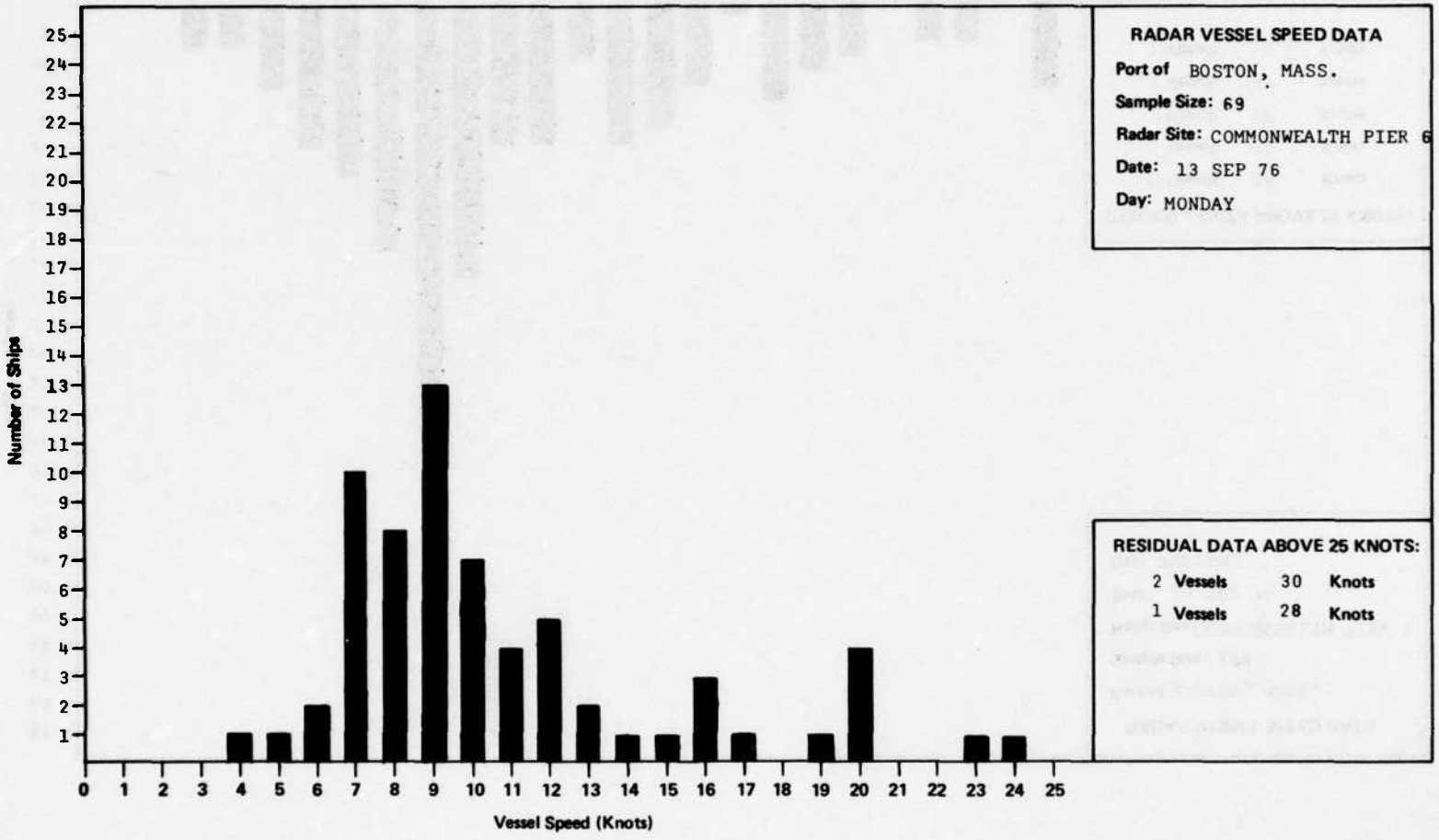

RADAR VESSEL SPEED DATA
Port of BOSTON, MASS.
Sample Size: 69
Radar Site: COMMONWEALTH PIER 6
Date: 13 SEP 76
Day: MONDAY
RESIDUAL DATA ABOVE 25 KNOTS:
2 Vessels 30 Knots
1 Vessels 28 Knots
Number of Ships
Vessel Speed (Knots)

FIGURE 4-11

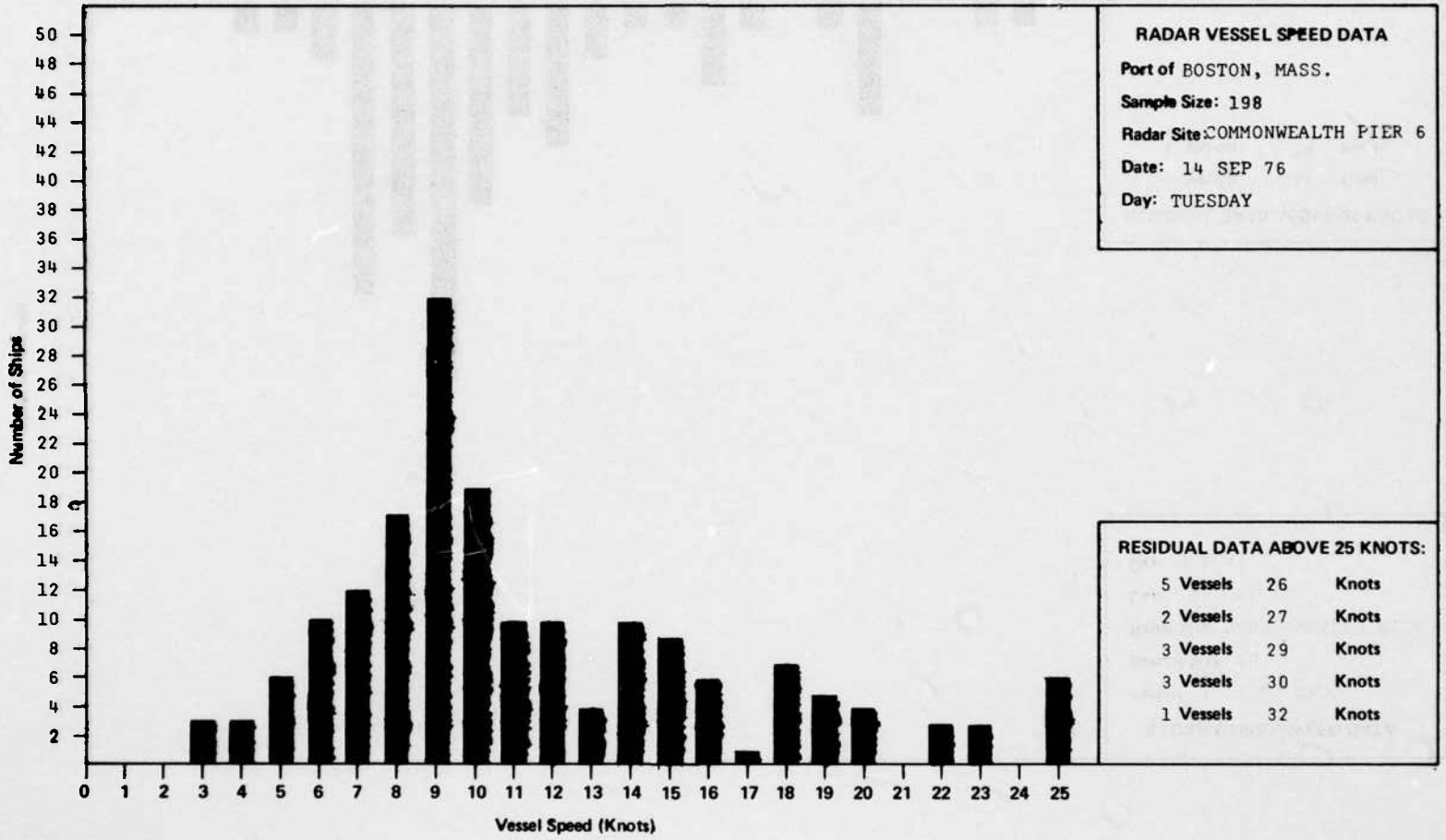

RADAR VESSEL SPEED DATA
Port of BOSTON, MASS.
Sample Size: 198
Radar Site: COMMONWEALTH PIER 6
Date: 14 SEP 76
Day: TUESDAY
RESIDUAL DATA ABOVE 25 KNOTS:
5 Vessels 26 Knots
2 Vessels 27 Knots
3 Vessels 29 Knots
3 Vessels 30 Knots
1 Vessels 32 Knots
Number of Ships
Vessel Speed (Knots)

FIGURE 4-12

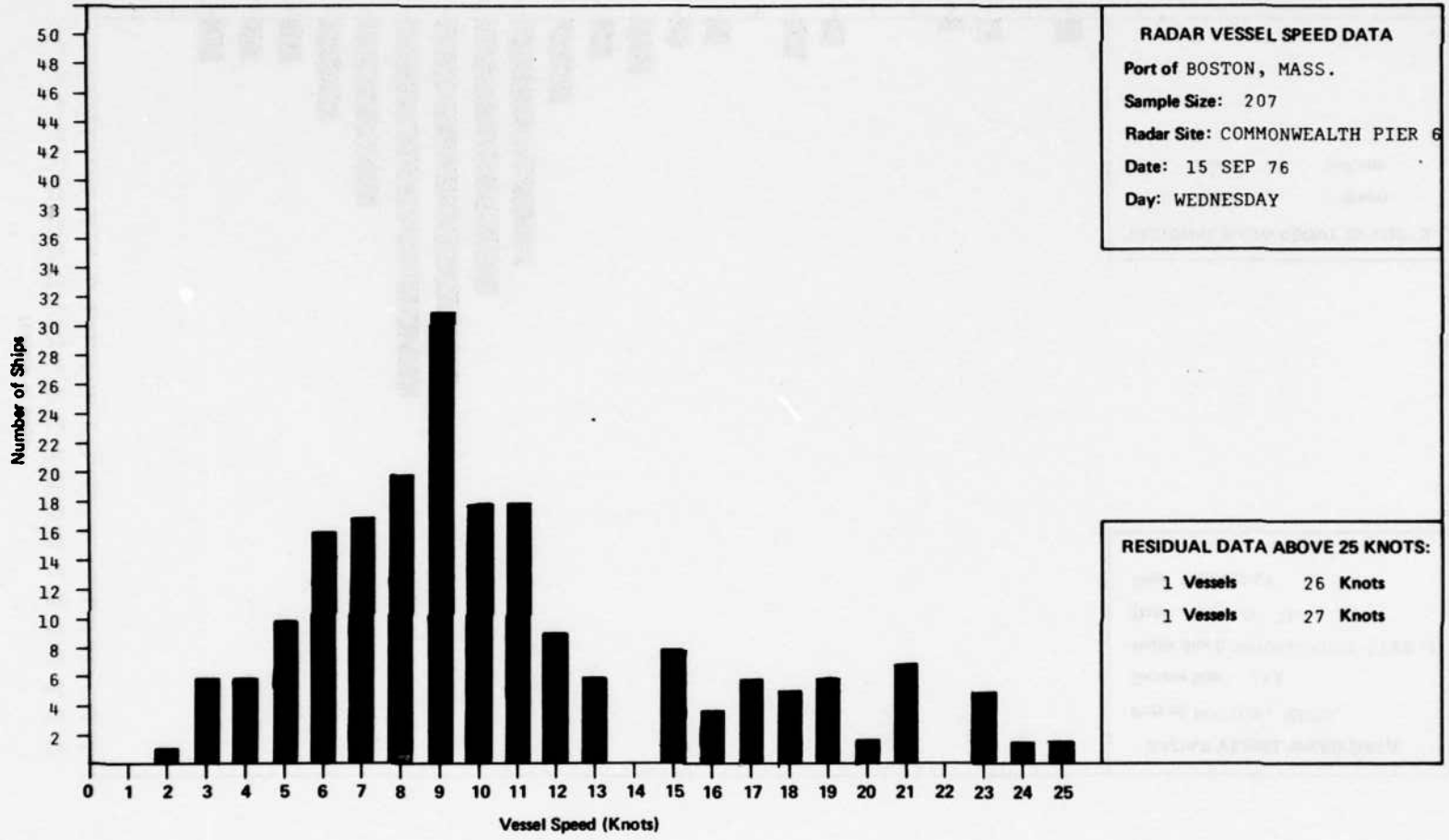

RADAR VESSEL SPEED DATA
Port of BOSTON, MASS.
Sample Size: 207
Radar Site: COMMONWEALTH PIER 6
Date: 15 SEP 76
Day: WEDNESDAY
RESIDUAL DATA ABOVE 25 KNOTS:
1 Vessels 26 Knots
1 Vessels 27 Knots
Number of Ships
Vessel Speed (Knots)

FIGURE 4-13

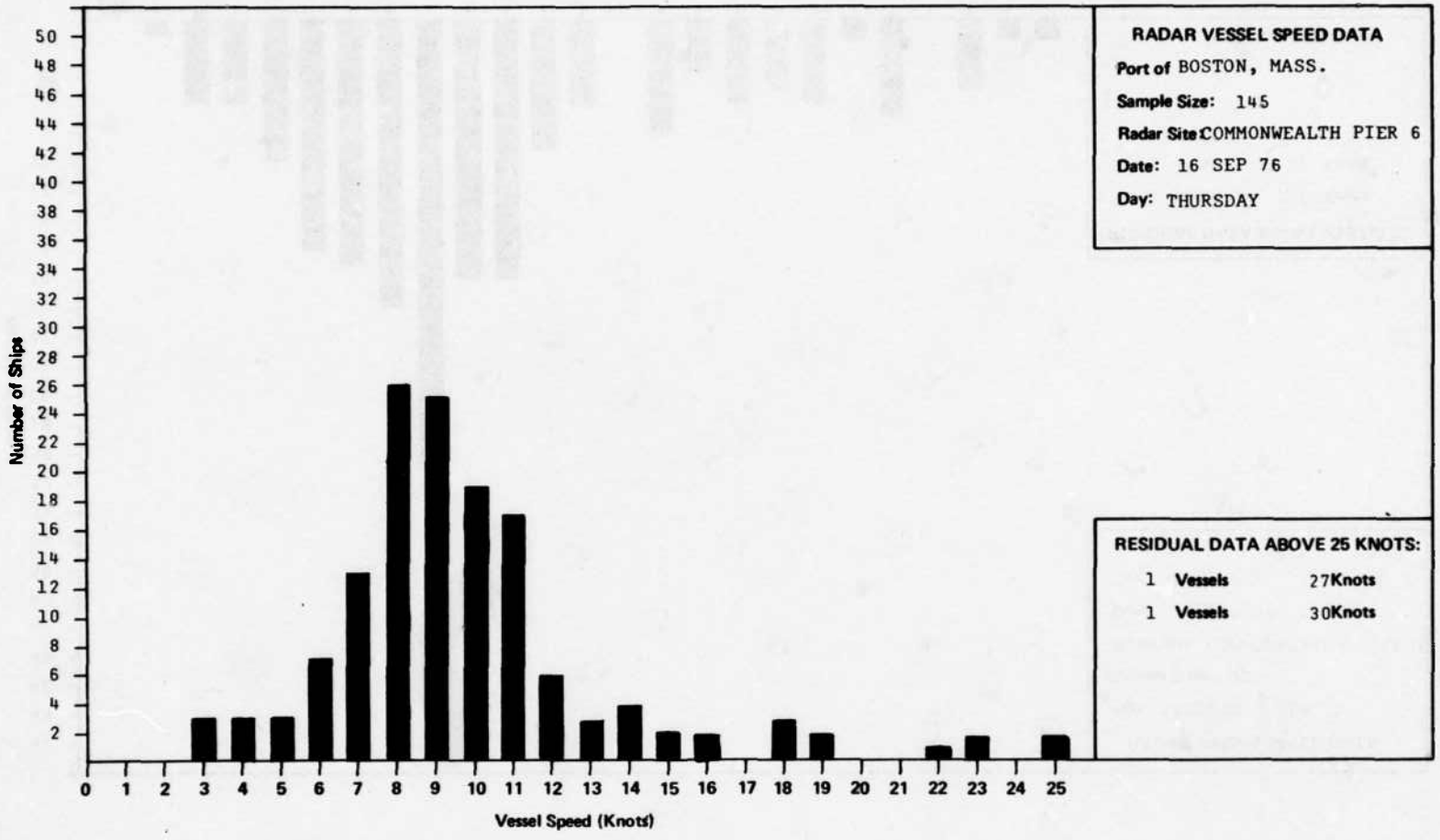

RADAR VESSEL SPEED DATA
Port of BOSTON, MASS.
Sample Size: 145
Radar Site: COMMONWEALTH PIER 6
Date: 16 SEP 76
Day: THURSDAY
RESIDUAL DATA ABOVE 25 KNOTS:
1 Vessels 27Knots
1 Vessels 30Knots
Number of Ships
Vessel Speed (Knots)

FIGURE 4-14

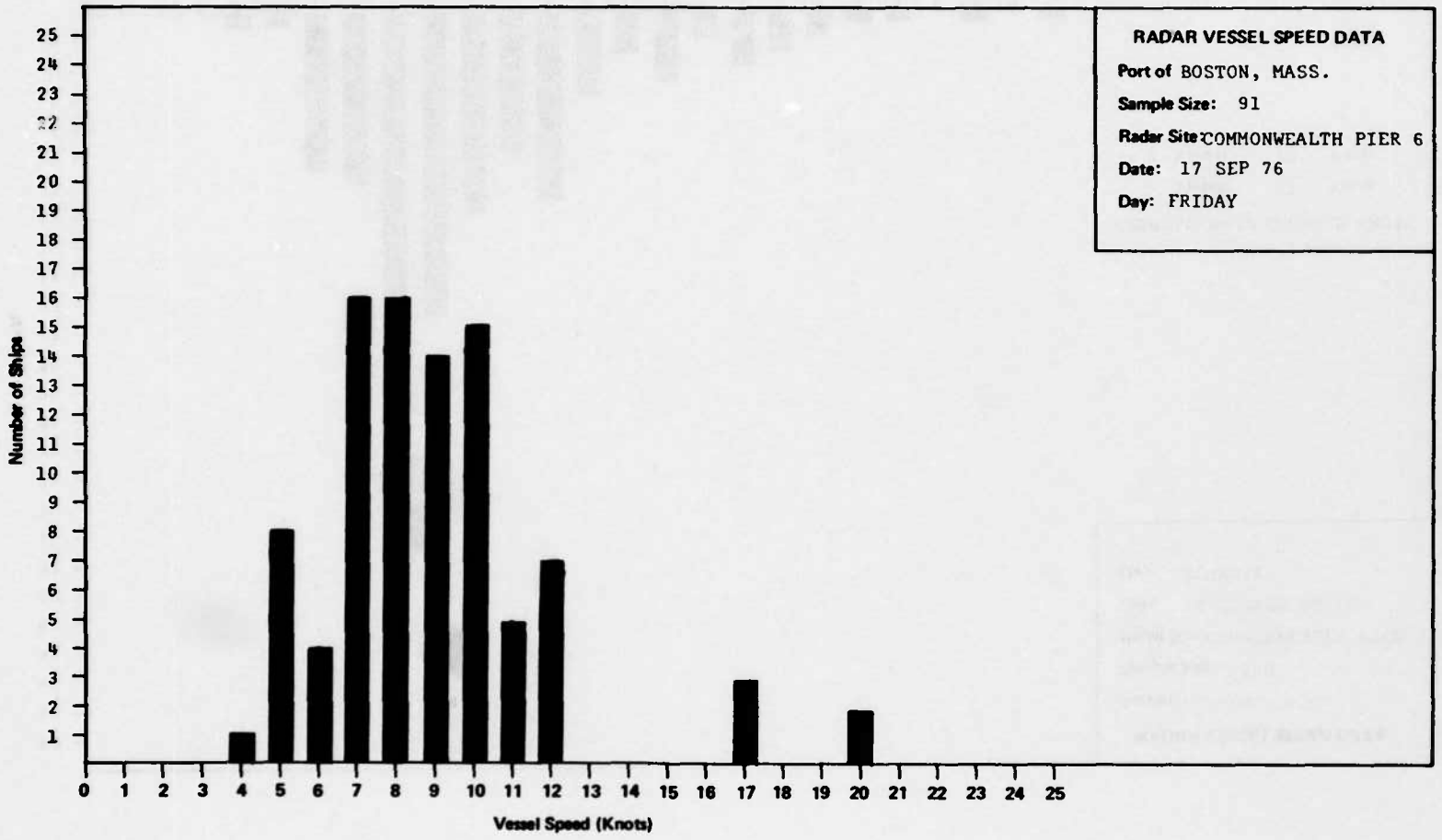

RADAR VESSEL SPEED DATA
Port of BOSTON, MASS.
Sample Size: 91
Radar Site: COMMONWEALTH PIER 6
Date: 17 SEP 76
Day: FRIDAY
Number of Ships
Vessel Speed (Knots)

FIGURE 4-15

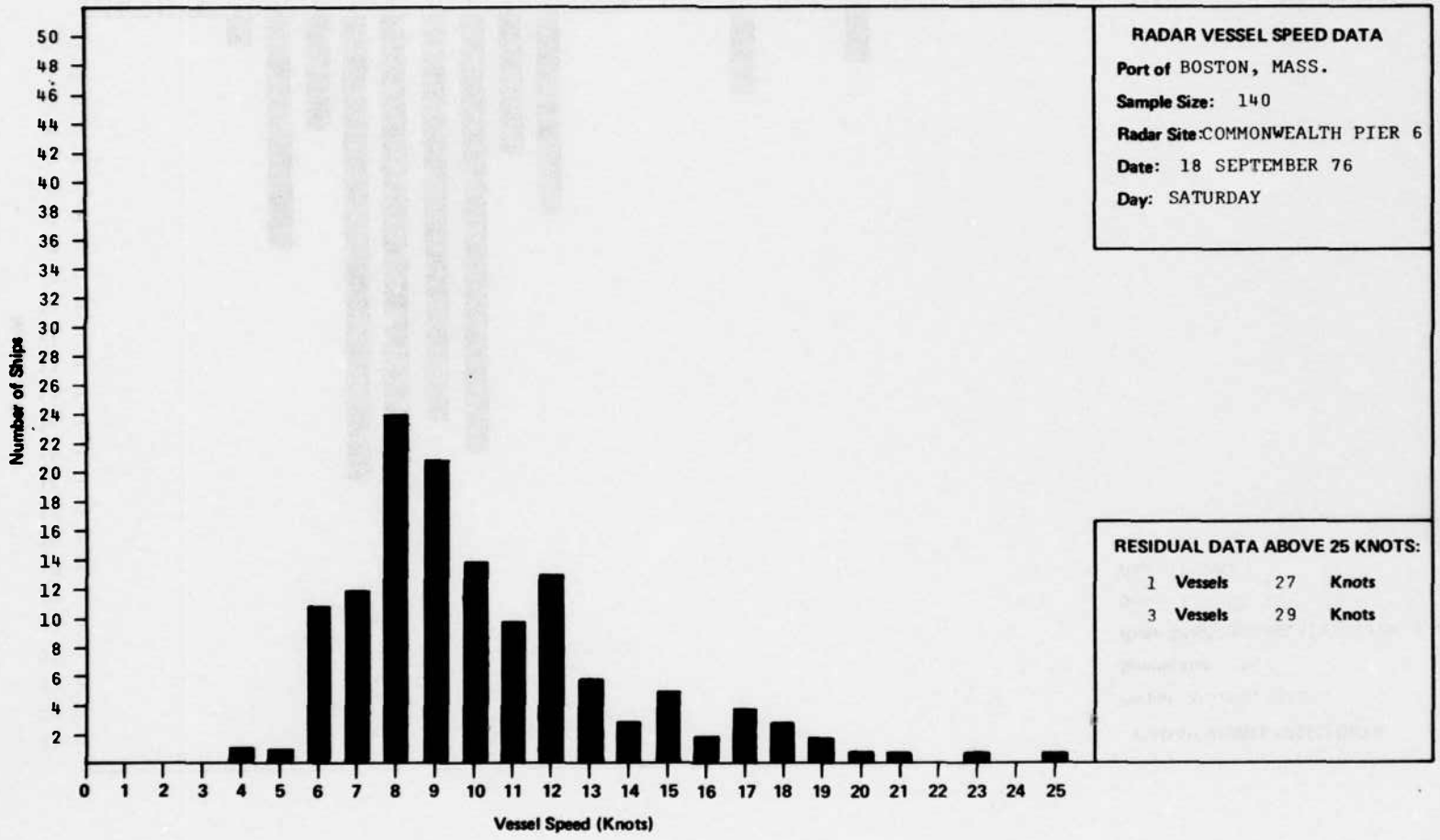

RADAR VESSEL SPEED DATA
Port of BOSTON, MASS.
Sample Size: 140
Radar Site: COMMONWEALTH PIER 6
Date: 18 SEPTEMBER 76
Day: SATURDAY
RESIDUAL DATA ABOVE 25 KNOTS:
1 Vessels 27 Knots
3 Vessels 29 Knots
Number of Ships
Vessel Speed (Knots)

FIGURE 4-16

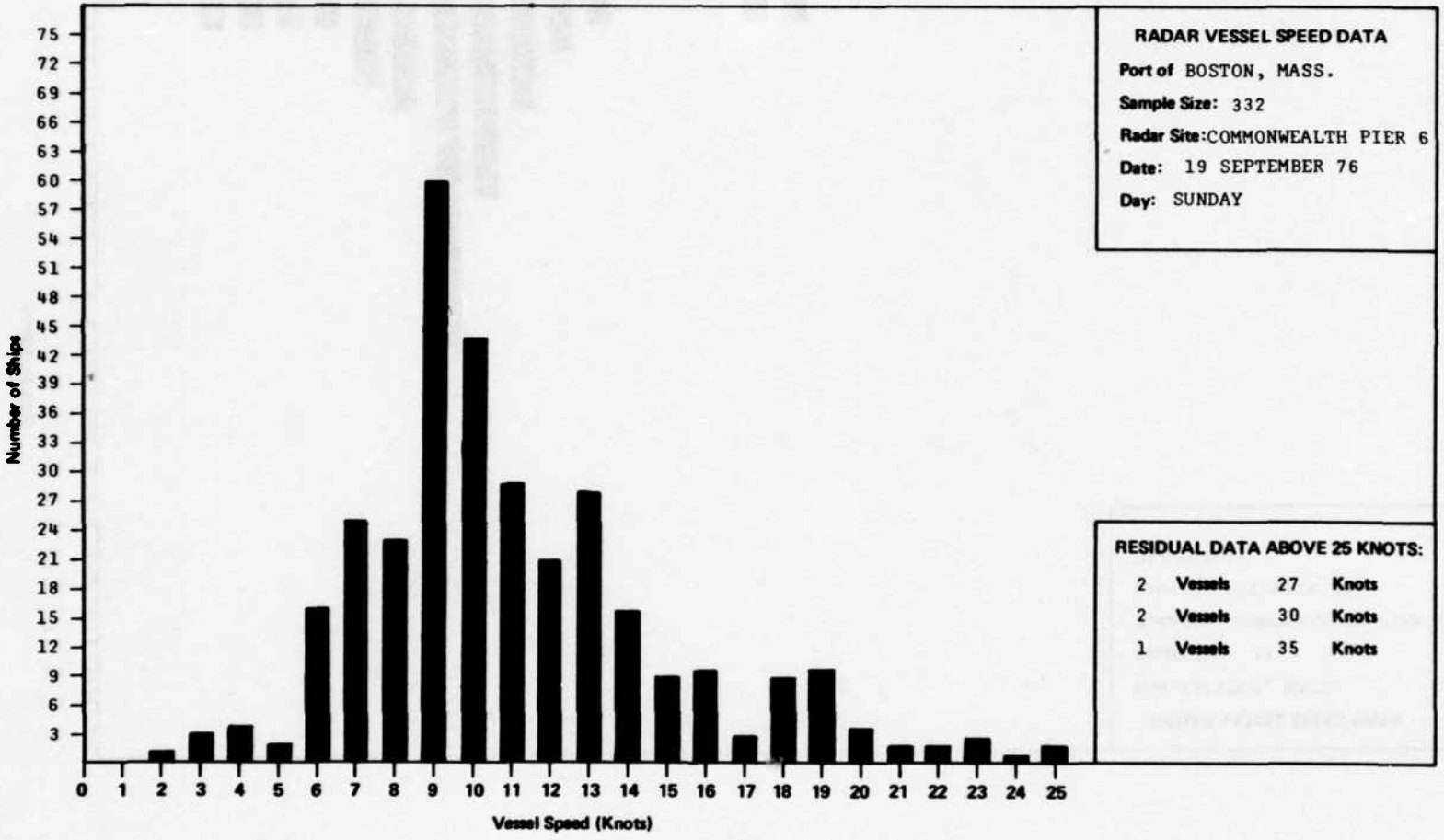

RADAR VESSEL SPEED DATA
Port of BOSTON, MASS.
Sample Size: 332
Radar Site:COMMONWEALTH PIER 6
Date: 19 SEPTEMBER 76
Day: SUNDAY
RESIDUAL DATA ABOVE 25 KNOTS:
2 Vessels 27 Knots
2 Vessels 30 Knots
1 Vessels 35 Knots
Number of Ships
Vessel Speed (Knots)

FIGURE 4-17

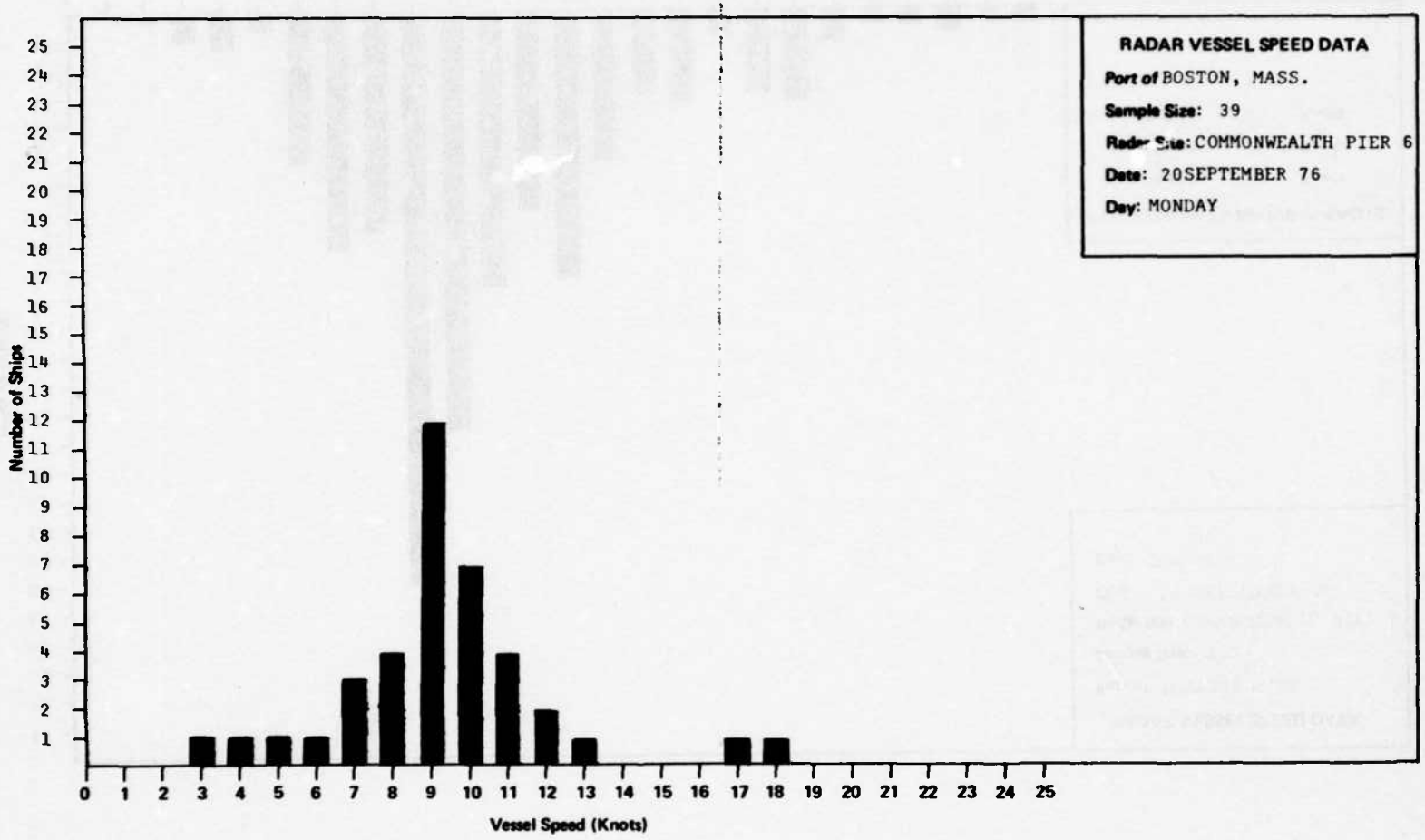

RADAR VESSEL SPEED DATA
Port of BOSTON, MASS.
Sample Size: 39
Radar Site: COMMONWEALTH PIER 6
Date: 20SEPTEMBER 76
Day: MONDAY
Number of Ships
Vessel Speed (Knots)

FIGURE 4-18

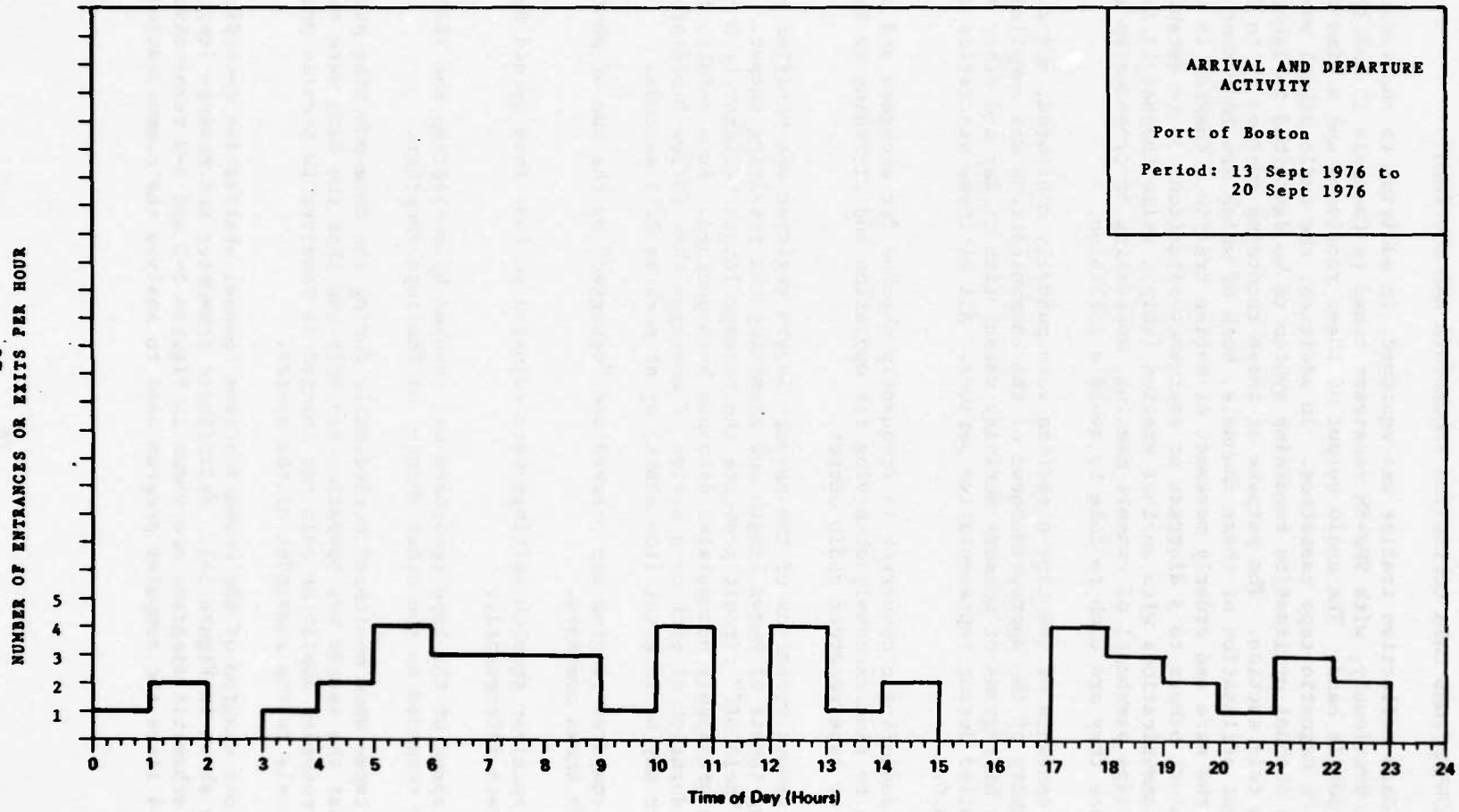

ARRIVAL AND DEPARTURE ACTIVITY
Port of Boston
Period: 13 Sept 1976 to 20 Sept 1976
NUMBER OF ENTRANCES OR EXITS PER HOUR
1
2
3
4
5
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day (Hours)

FIGURE 4-19

5.0 COMMUNICATIONS DATA COLLECTION PROCEDURES AND EQUIPMENT

The data collection trailer was equipped, in addition to the radar system mentioned previously, with VHF-FM receivers tuned to Channels 13 and 16 in the maritime mobile band. The audio output of these receivers and a time code was recorded on magnetic tape cassettes. In addition, the audio signal was sent to automated channel utilization recording system to be described in later paragraphs in this section. The purpose of these recording systems is to document the present utilization of these channels, both of which are important to insuring the safe and orderly movement of marine traffic. Channel 16 is to be used to alert others to a distress or emergency situation, or to establish initial communications with another station (ship), while Channel 13 is to be used by the bridge personnel of vessels meeting, overtaking or crossing to agree on the actions they are each to take to avoid a collision.

The contents of the tape cassettes were manually monitored, and a statistical summary of the appropriateness of the communications was compiled. In addition, histograms of message activity versus time of day and other statistics were compiled during representative periods. All of these statistics appear in Section 6.0.

The audio/logic converter is frequently checked for accuracy and proper operation by simultaneously observing its operation and listening to the receiver or tape recorder audio output.

The proper operation of the message length register was verified by generating inputs of known length and examining the resulting output. Note that the "hold off" circuit prevents the message length register from operating until the previously accumulated data has been punched. As a result, the measured duration of each of a series of messages that follow immediately after each other may be in error (too short) by as much as 0.15 seconds.

The computer program was checked and "debugged" by the use of short data tapes with known contents.

The receiver squelch settings were adjusted so that they opened due to noise bursts infrequently.

The speed of the tape recorders was checked by monitoring the IRIG-format time code recorded on the other channel of the tape recorder.

The tapes were monitored periodically during the data-punching process to insure that the system was operating properly and that the data were reasonable. The tape recorder amplifier gain was changed as required to provide proper signal levels to the remainder of the system.

A block diagram of the communications channel utilization recording system is shown in Figure 5-1. Audio/logic converter and message length register schematic diagrams are shown in Figures 5-2 and 5-3 respectively. Figure 5-4 lists the computer program used to analyze the communications data.

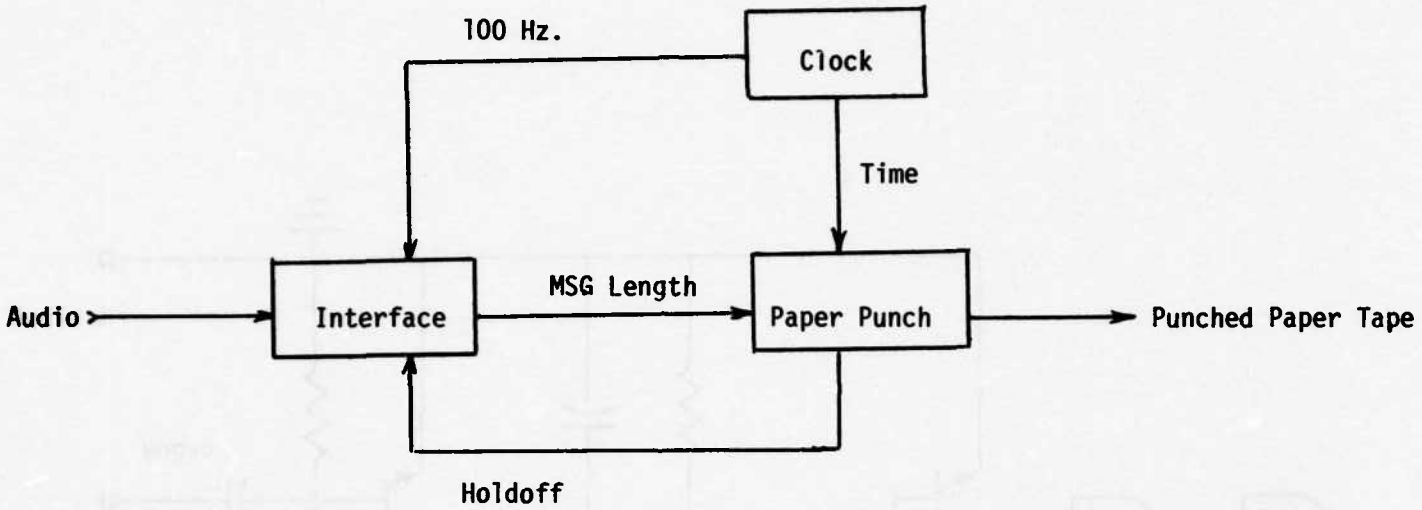


FIGURE 5-1

CHANNEL UTILIZATION RECORDING SYSTEM BLOCK DIAGRAM

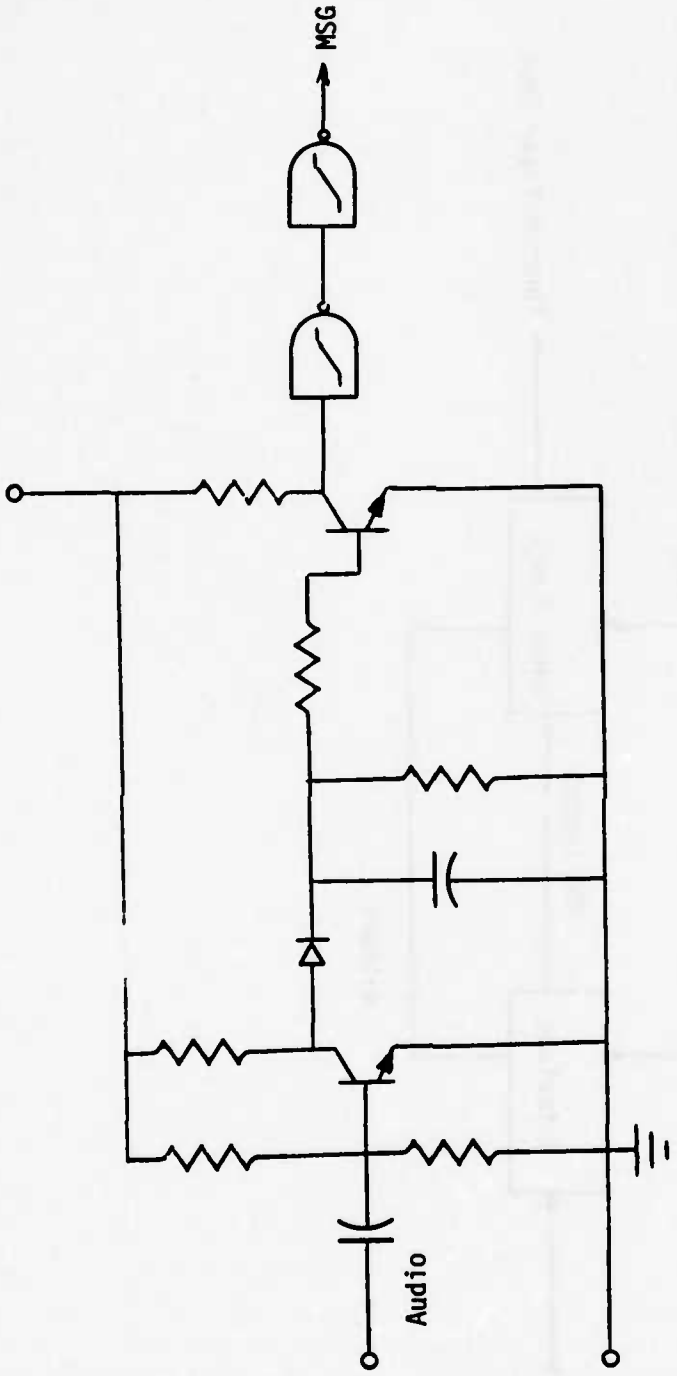


FIGURE 5-2
AUDIO/LOGIC CONVERTER

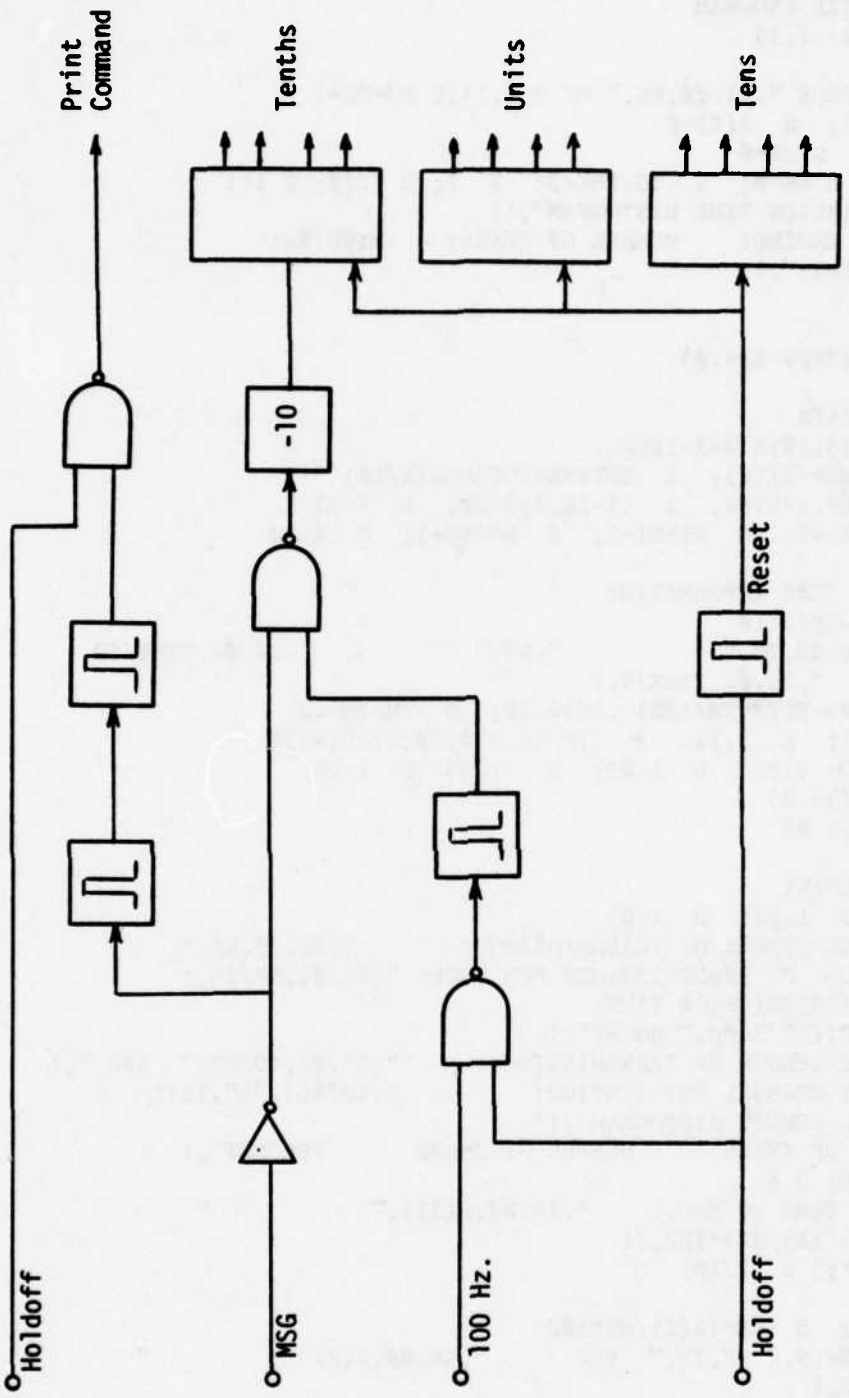


FIGURE 5-3
MESSAGE LENGTH REGISTER

```
C-FOCAL, 1969

01.01  C  INITIALIZE PROGRAM
01.02  D  7.10;  D  7.15
01.04  S  PG=1
01.05  T  "      PAGE ",%1.00,PG," OF 3 ",!!;S PG=PG+1
01.10  F  Z=1,1,21;  S  A(Z)=0
01.11  S  TIME=0;  S NT=0
01.12  S  TM=15;  S NR=0;  S  TOTIME=0;  T  !; D 7.20; T !!!
01.22  T  "TRANSMISSION TIME HISTOGRAM",!!
01.23  T  "PERIOD ENDING:    NUMBER OF XMSNS:    MINUTES:        "
01.24  T  "  PERCENT:",!

02.05  *
02.10  A  X;  I  (3999-X)4.05

03.04  C  HANDLE DATA
03.05  I  (X-1000)3,1;S X=X-1000
03.10  S  TIME=TIME+(X/10);  S  TOTIME=TOTIME+(X/10)
03.15  S  X=FITR(X*.199)+1;  I  (X-20.5)3.20;  S  X=21
03.20  S  A(X)=A(X)+1;  S  NT=NT+1;  S  NR=NR+1;  G  2.10

04.04  C  HANDLES TIME INFORMATION
04.05  I  (X-4000-TM)2.10
04.15  T  "   ",%6.00,TM,"          ",NT,"          ",%4.02,TIME/60
04.20  T  "        ",%6.02,TIME/9,!
04.25  I  ((TM/100)-FITR(TM/100)-.40)4.30;  S  TM=TM+40
04.30  S  TM=TM+15;  D  1.11;  I  (TM-1215)4.50,4.45,4.50
04.45  D  7.10;  D  1.02;  D  1.05;  D  1.23;  D  1.24
04.50  I  (TM-2400)4.05
04.55  I  (X-6400)4.05

05.04  C  DATA SUMMARY
05.05  D  7.10;  D  1.02;  D  1.05
05.10  T  !!,"TMTAL NUMBER OF TRANSMISSIONS:       ",%5.00,NR,!
05.15  T  "AVE. NUM. OF TRANSMISSIONS PER HOUR: ",%4.01,NR/24,!
05.20  T  "TOTAL TRANSMISSION TIME:                "
05.21  T  %5.03,TOTIME/3600," HOURS",!
05.25  T  "AVERAGE LENGTH OF TRANSMISSION:      ",%5.02,TO/NR,"  SEC.",!
05.30  T  "PERCENT CHANNEL UTILIZATION:         ",TO/864,"%",!!!!
05.35  T  "MESSAGE LENGTH HISTOGRAM",!!
05.40  T  "LENGTH OF XMSNS      NUMBER OF XMSNS      PERCENT",!
05.45  F  Z=1,1,20; D 6
05.50  T  "LONGER THAN 10 SEC.:    ",%4.00,A(21),"          "
05.55  T  %6.02,(A(21)/NR)*100,!!
05.60  S  PG=1;  *;  D  7.10;  Q

06.10  S  TD=Z*.5;  S  PN=(A(Z)/NR*100
06.15  T  %3.01,TD-.5," -",TD,"  SEC.     ",%6.00,A(Z)          "
06.16  T  %6.02,PN,!

07.10  T  "";  C  FORM FEED
07.15  T  "BOSTON HARBOR, MASS.    9/14/76"
07.20  T  "VHF-FM  CH  13  XMSN STATISTICS"
```

FIGURE 5-4

COMPUTER PROGRAM TO ANALYZE RADIO COMMUNICATIONS DATA

DEFINITION OF VARIABLES:

A(Z)	Length of transmission count for Message Length Histogram
NR	Total number of transmissions
NT	Total number of transmissions in 15 minute interval being analyzed
PG	Page number
PN	Temporary variable used to establish percent of transmissions with specific message length
TD	Temporary variable used to establish length of transmissions for Message Length Histograms
TIME	Total time of transmissions found in 15 minute interval being analyzed
TM	Upper time limit of 15 minute interval being analyzed
TOTIME	Total time of all transmissions
X	Number read from data tape and dummy variable in "HANDLE DATA"

FIGURE 5-4 (Continued)

6.0 COMMUNICATIONS DATA ANALYSIS RESULTS

This section (Figures 6-1 through 6-32) contains the results of the analysis of about 158 hours of communications traffic from VHF-FM Channels 13 and 16 recorded during the period 13 to 20 September 1976. The receiving antennas were located on the northeastern corner of Commonwealth Pier 6, at 42°21'06"N., 71°02'14"W., and at a height of about 30 feet above sea level. As mentioned previously, these recordings were monitored manually to prepare the communications channel efficiency histograms. These histograms indicate the percentage of messages transmitted that were appropriate for the particular channel that was used. Also, automated equipment was used to prepare histograms of message activity and channel utilization for representative intervals during this period. With respect to the computer-prepared histograms (Figures 6-33 through 6-36):

- Note that the figures in the column headed "PERIOD ENDING" are time intervals printed without the customary leading zeros. Thus, the time "0015" is shown as "15". The "MINUTES" column contains the total time occupied by transmissions during the period, while the "PERCENT" column shows the percentage of the given period during which the channel was in use.

- It is probable that a number of the messages of less than 0.5 seconds in length are simply noise bursts. However, since it is common practice to acknow ledge a transmission by briefly keying the transmitter (with no voice modulation), it did not seem desirable to ignore any usable signal. Thus, the figures for messages of less than 0.5 seconds duration should also be used with caution. With respect to the Communications Message Activity histograms, a "valid" message is one that is appropriate for the channel that was used. This includes the exchange of navigational or maneuvering information on Channel 13, and calls to initially establish communications on Channel 16.

The "number of messages" counts occasionally differ between the manually-recorded data and the machine-reduced data. This difference is apparently due to the machine detecting breaks in the signals being transmitted that were either not detected or were ignored by the personnel performing the manual analysis. The figures on duration of channel utilization obtained manually agreed well with those obtained by the automated equipment, so it is believed that the automated equipment is working properly.

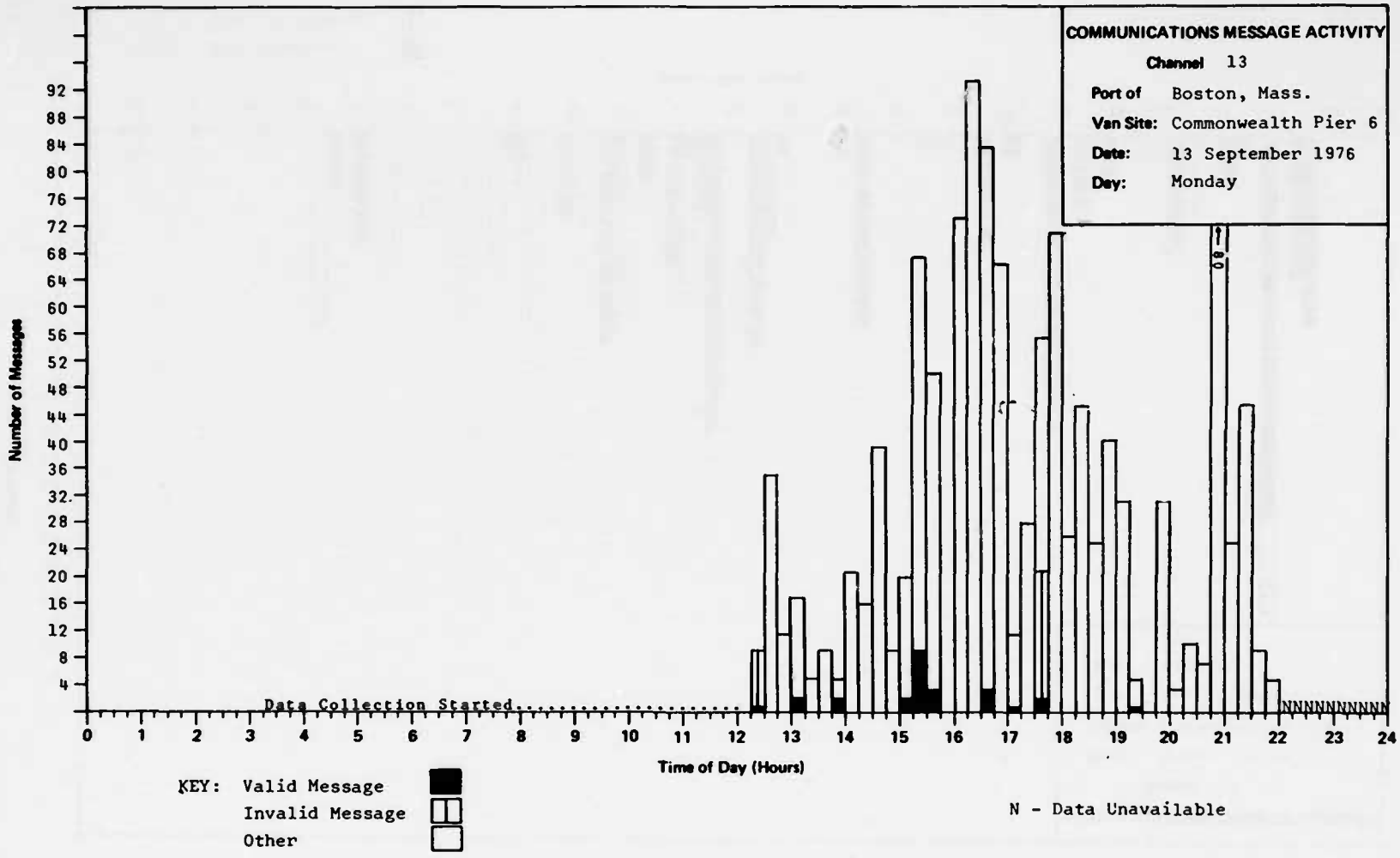

COMMUNICATIONS MESSAGE ACTIVITY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 13 September 1976
Day: Monday
Number of Messages
Time of Day (Hours)
Data Collection Started
NNNNNNNNNN
KEY: Valid Message
Invalid Message
Other
N - Data Unavailable

FIGURE 6-1

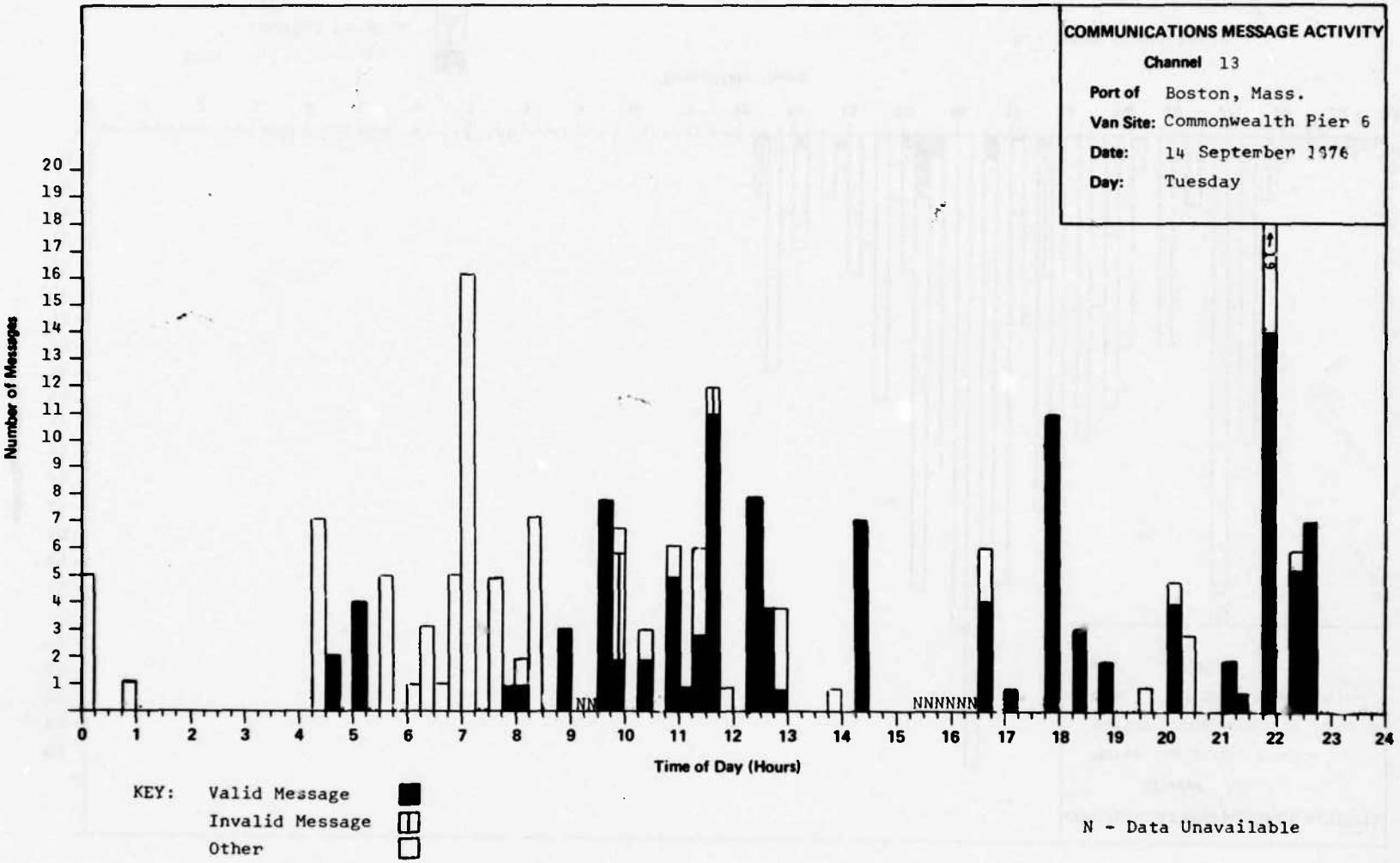

COMMUNICATIONS MESSAGE ACTIVITY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 14 September 1976
Day: Tuesday
Number of Messages
Time of Day (Hours)
NN
NNNNNN
KEY: Valid Message
Invalid Message
Other
N - Data Unavailable

FIGURE 6-2

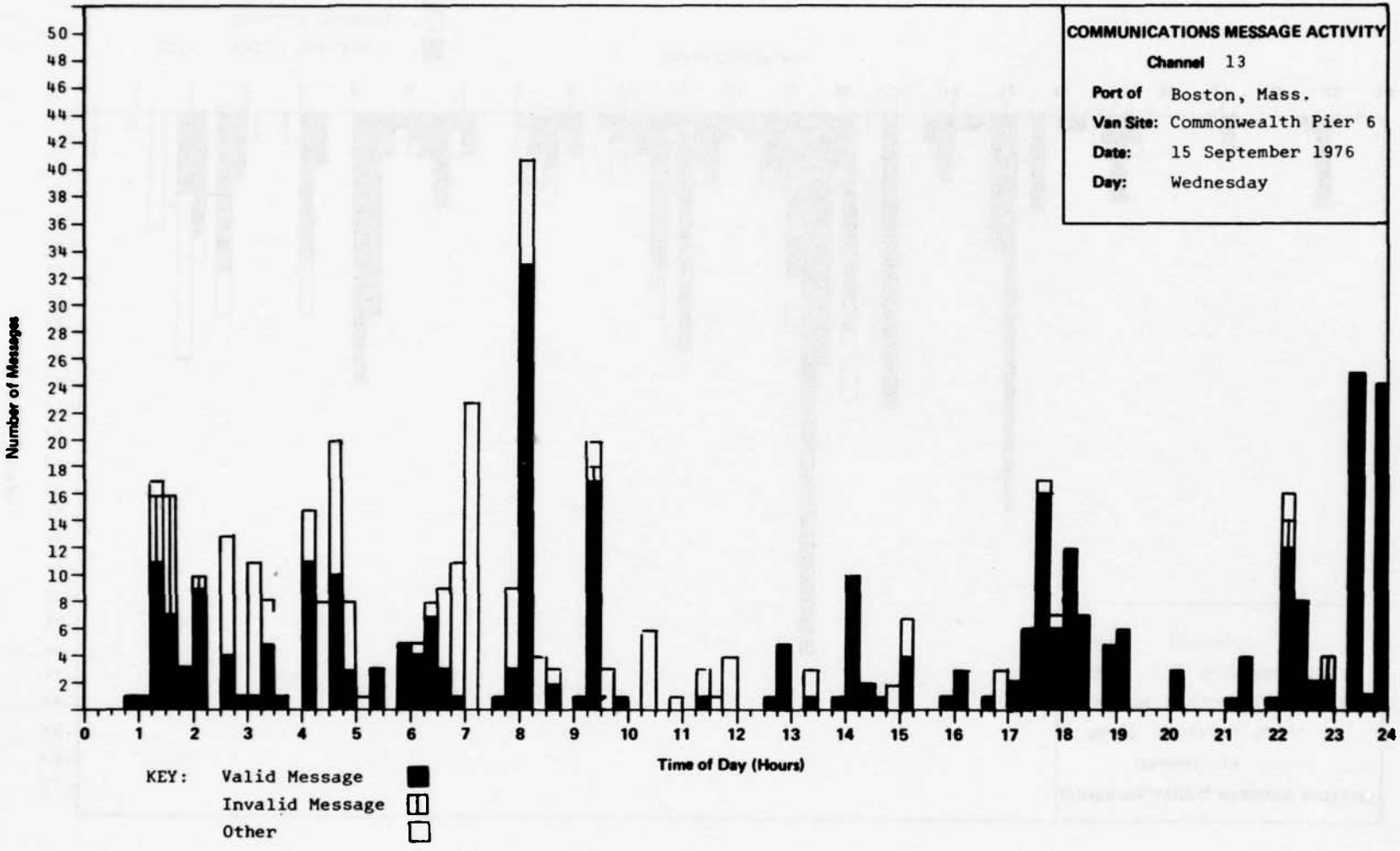

COMMUNICATIONS MESSAGE ACTIVITY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 15 September 1976
Day: Wednesday
Number of Messages
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other

FIGURE 6-3

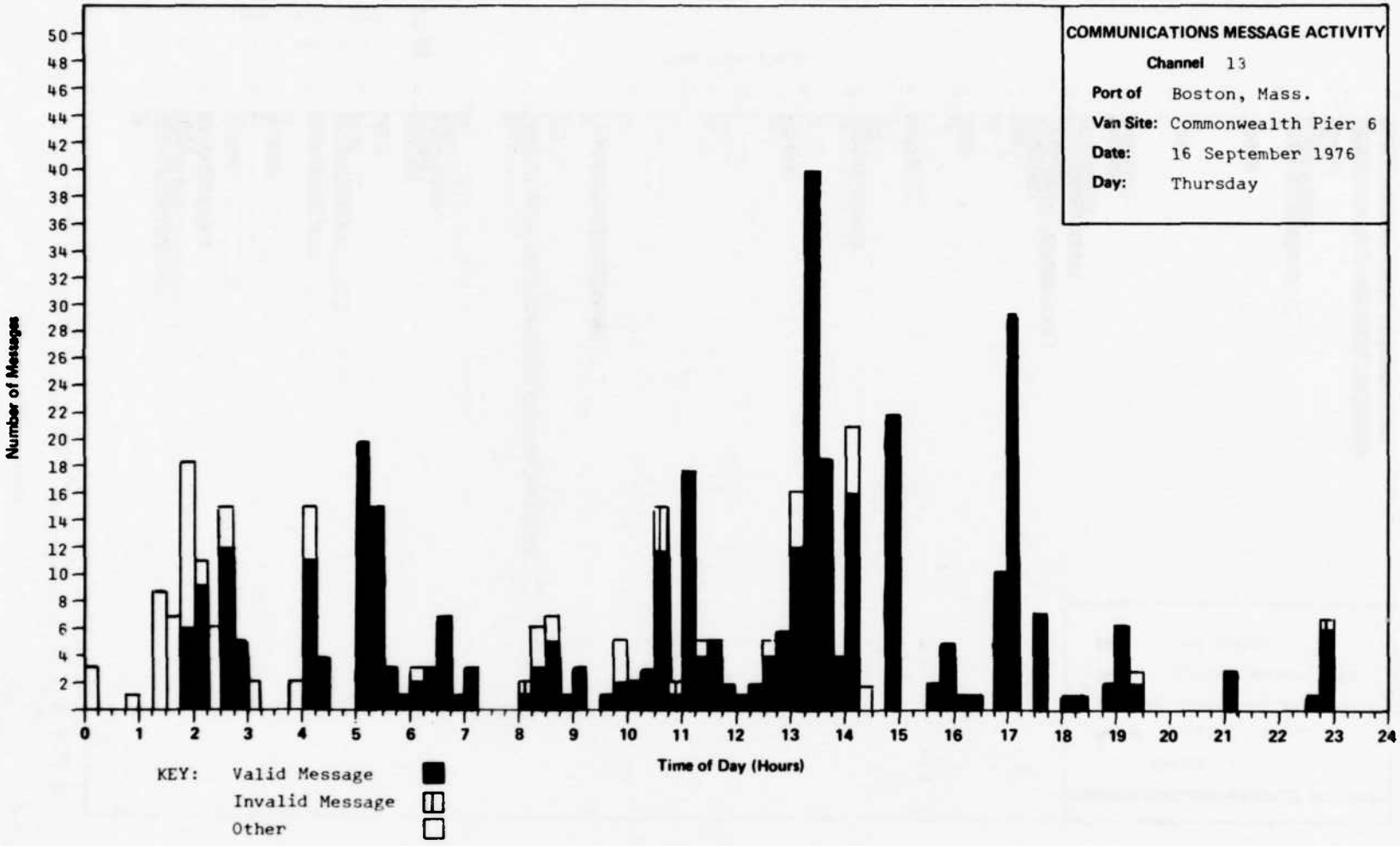

COMMUNICATIONS MESSAGE ACTIVITY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 16 September 1976
Day: Thursday
Number of Messages
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other

FIGURE 6-4

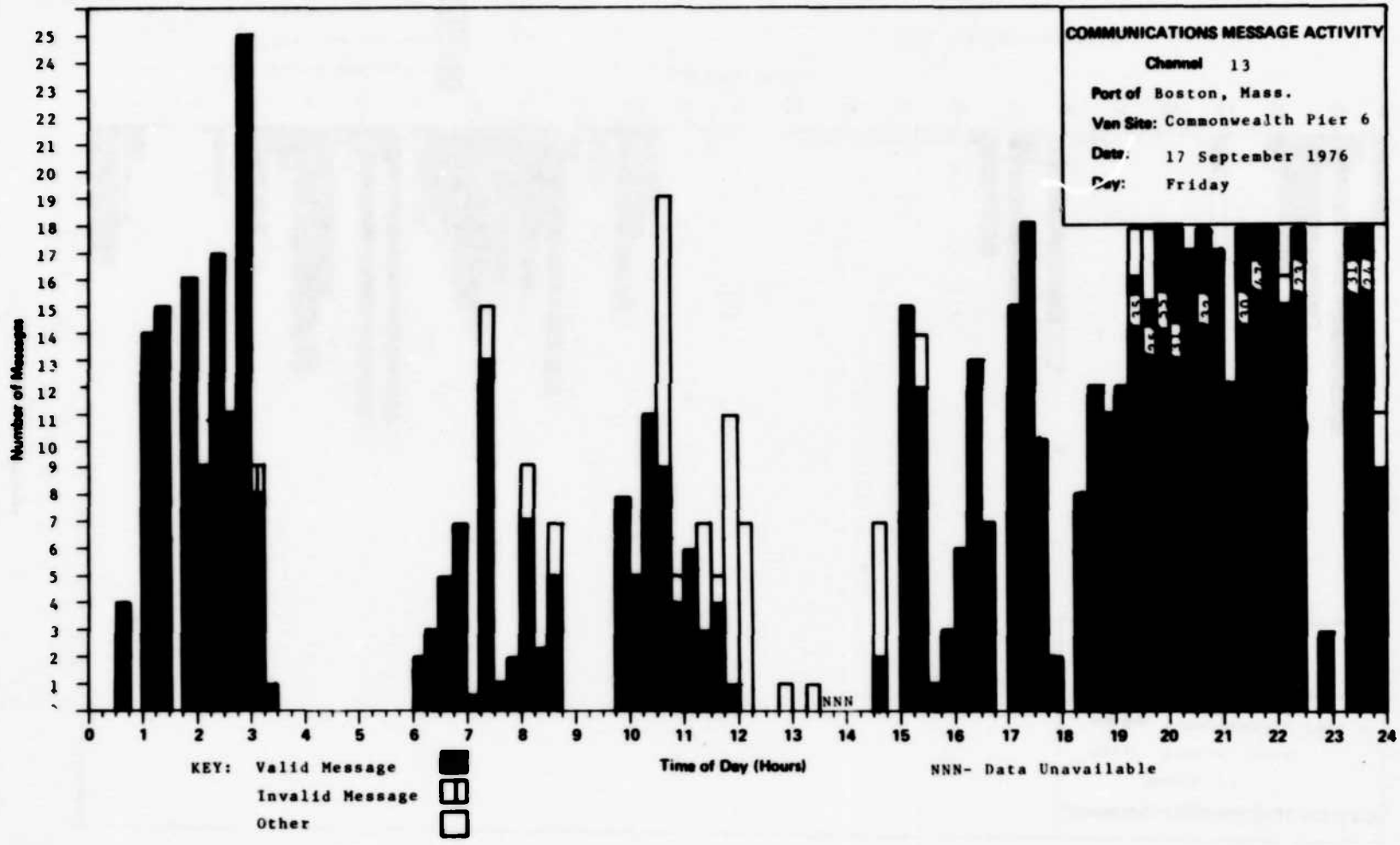

COMMUNICATIONS MESSAGE ACTIVITY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 17 September 1976
Day: Friday
Number of Messages
Time of Day (Hours)
NNN
KEY: Valid Message
Invalid Message
Other
NNN- Data Unavailable

FIGURE 6-5

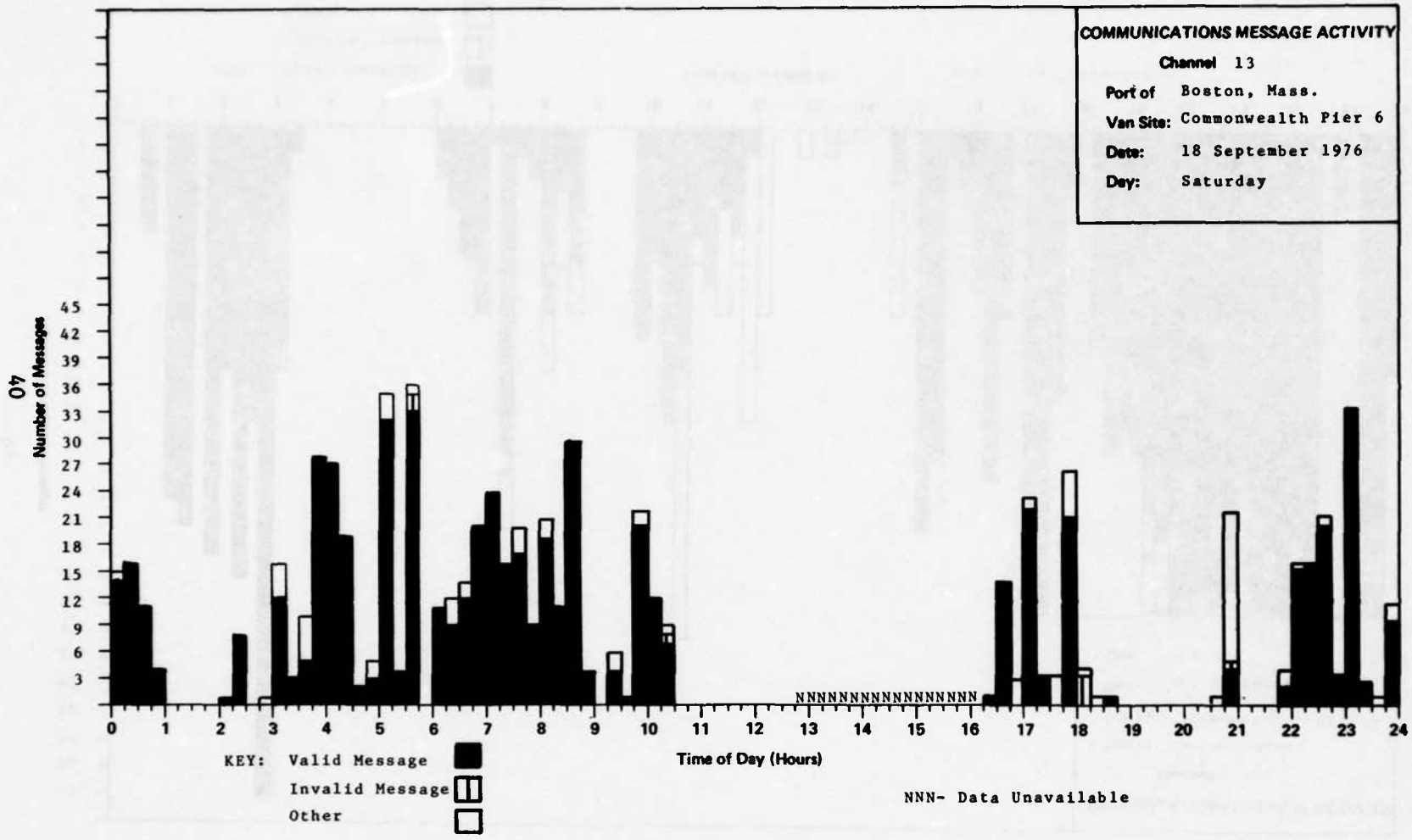

COMMUNICATIONS MESSAGE ACTIVITY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 18 September 1976
Day: Saturday
40
Number of Messages
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
NNNNNNNNNNNNNNNN
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other
NNN- Data Unavailable

FIGURE 6-6

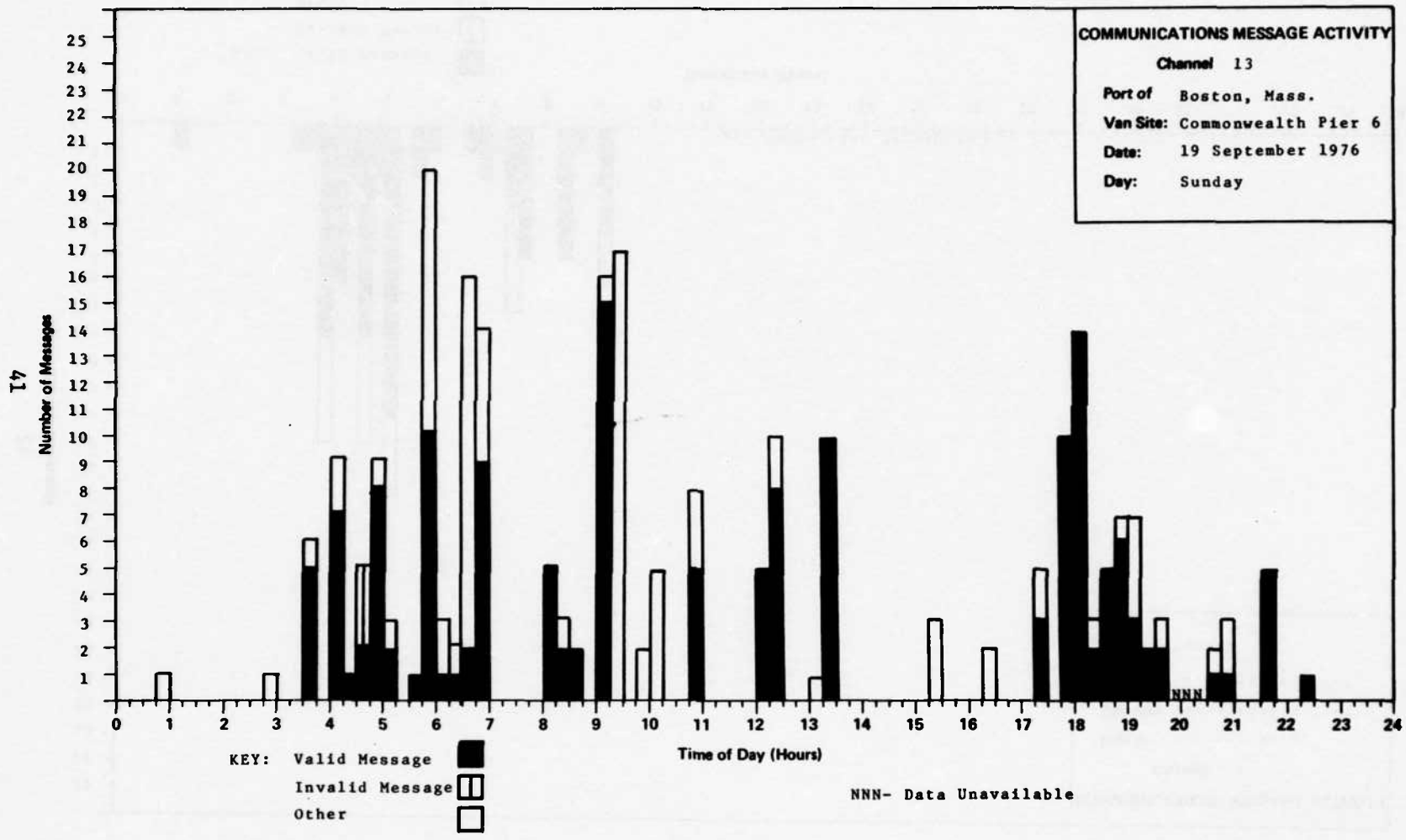

COMMUNICATIONS MESSAGE ACTIVITY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 19 September 1976
Day: Sunday
Number of Messages
Time of Day (Hours)
NNN
KEY: Valid Message
Invalid Message
Other
NNN- Data Unavailable

FIGURE 6-7

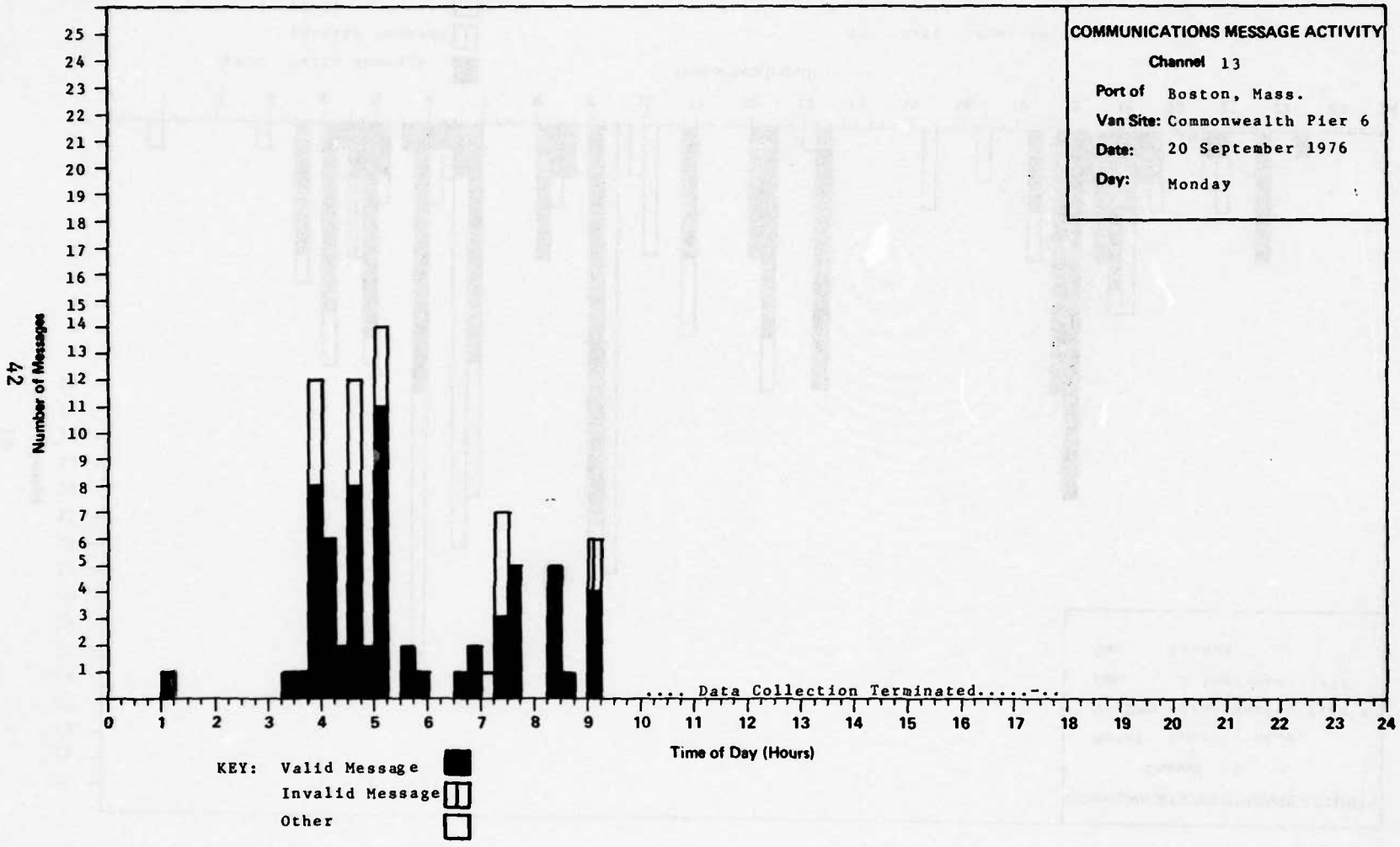

COMMUNICATIONS MESSAGE ACTIVITY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 20 September 1976
Day: Monday
Number of Messages
Time of Day (Hours)
.... Data Collection Terminated.....-..
KEY: Valid Message
Invalid Message
Other

FIGURE 6-8

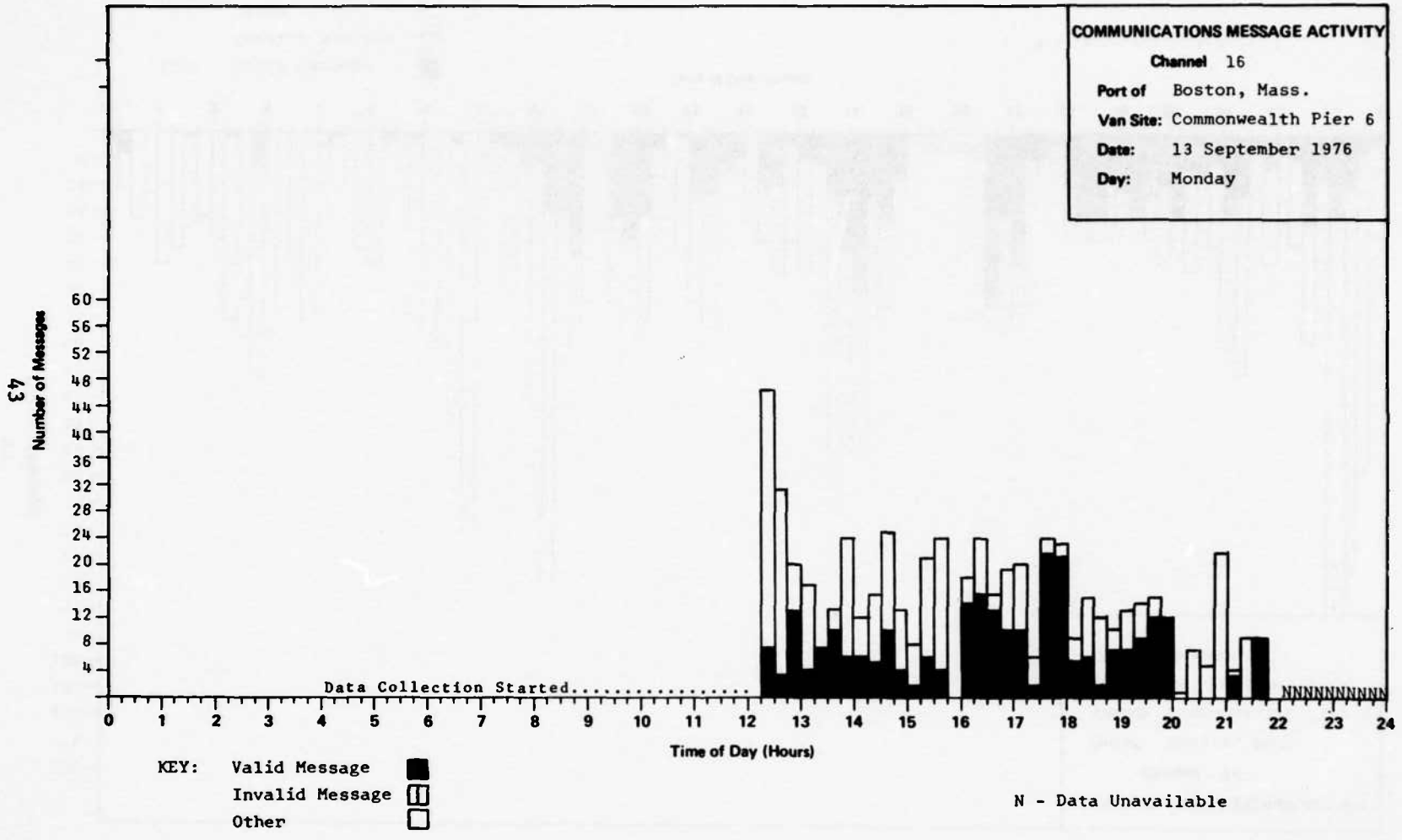

COMMUNICATIONS MESSAGE ACTIVITY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 13 September 1976
Day: Monday
Number of Messages
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4
Data Collection Started.....
NNNNNNNNNN
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other
N - Data Unavailable

FIGURE 6-9

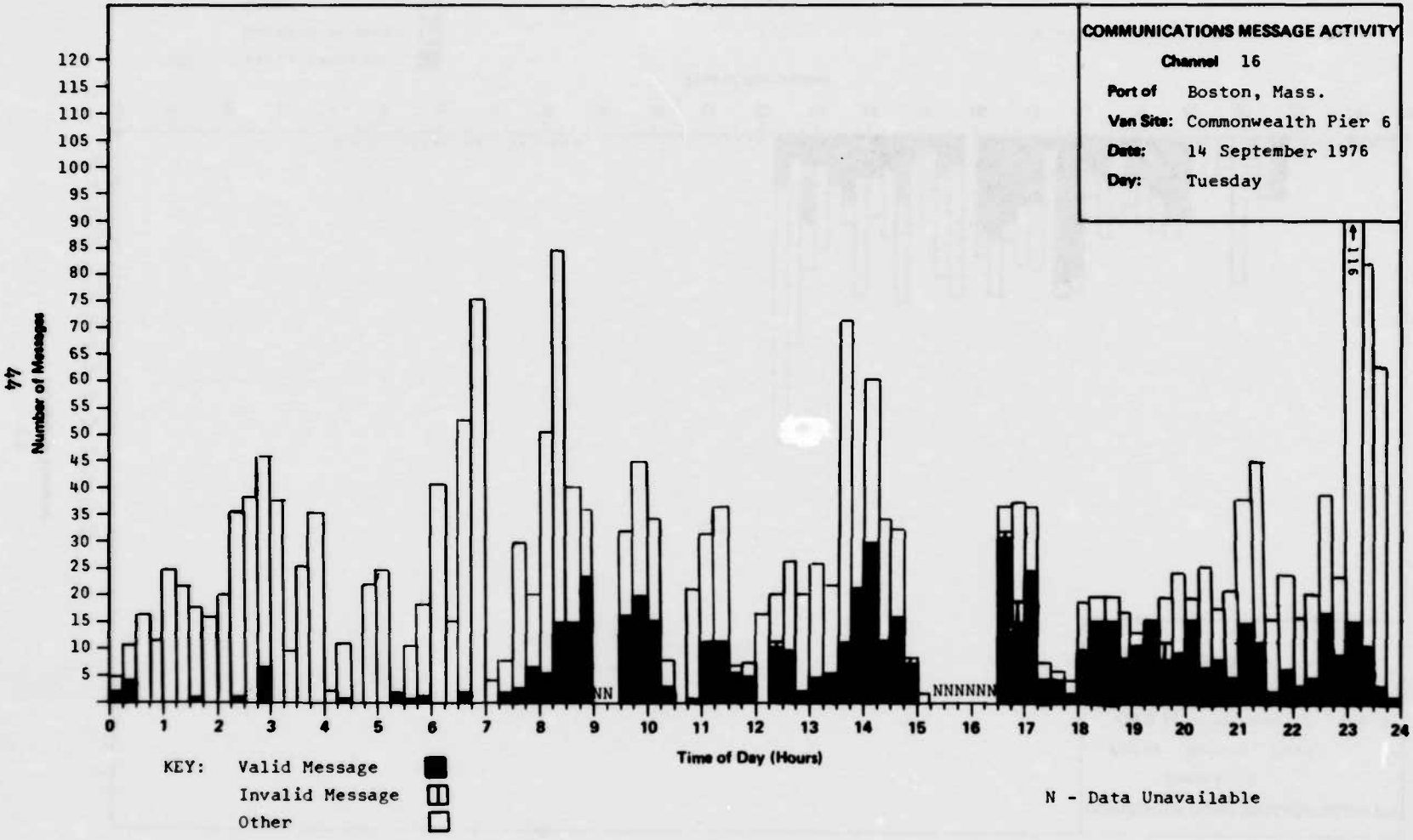

COMMUNICATIONS MESSAGE ACTIVITY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 14 September 1976
Day: Tuesday
Number of Messages
Time of Day (Hours)
116
NN
NNNNNN
KEY: Valid Message
Invalid Message
Other
N - Data Unavailable

FIGURE 6-10

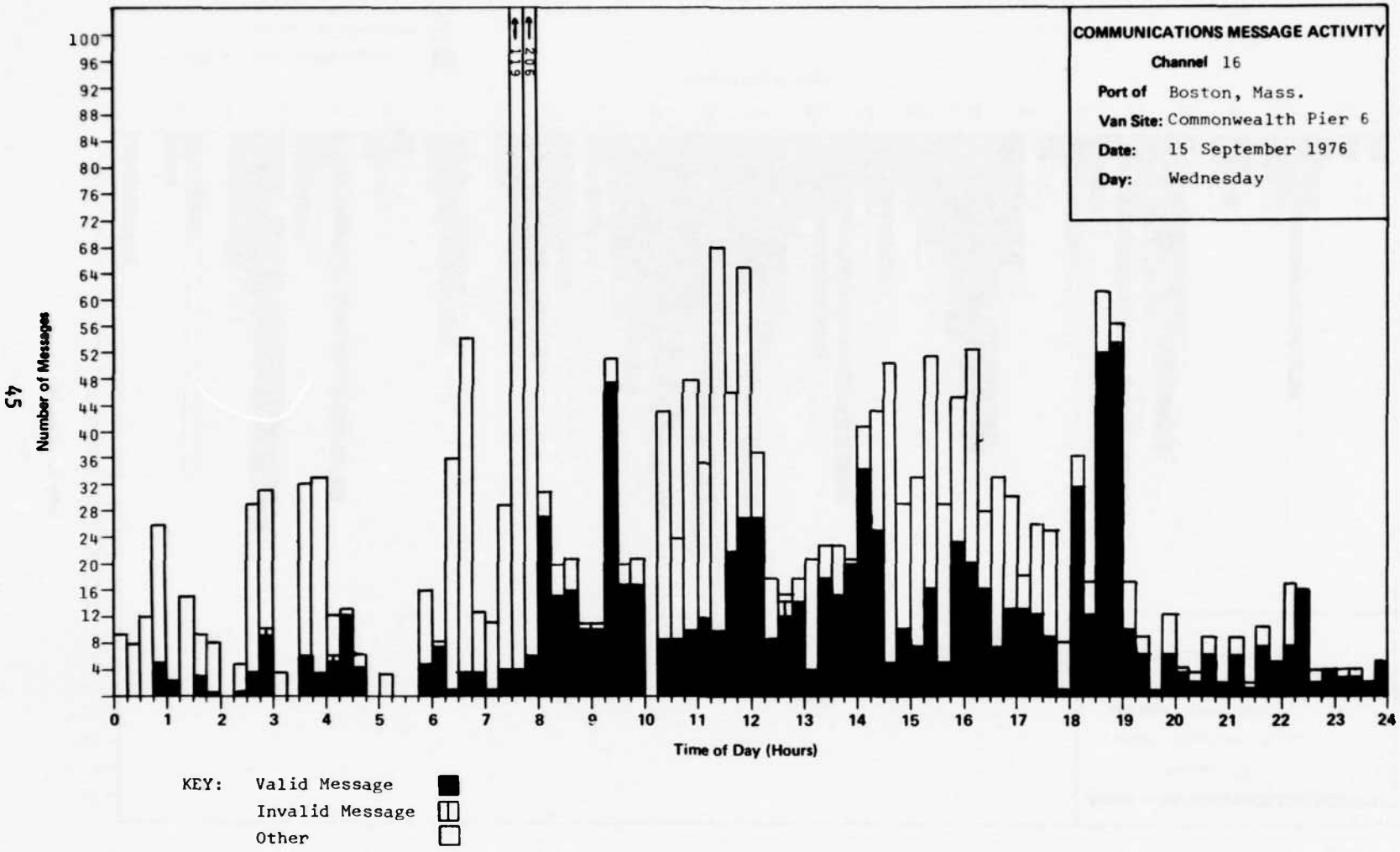

COMMUNICATIONS MESSAGE ACTIVITY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 15 September 1976
Day: Wednesday
Number of Messages
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other

FIGURE 6-11

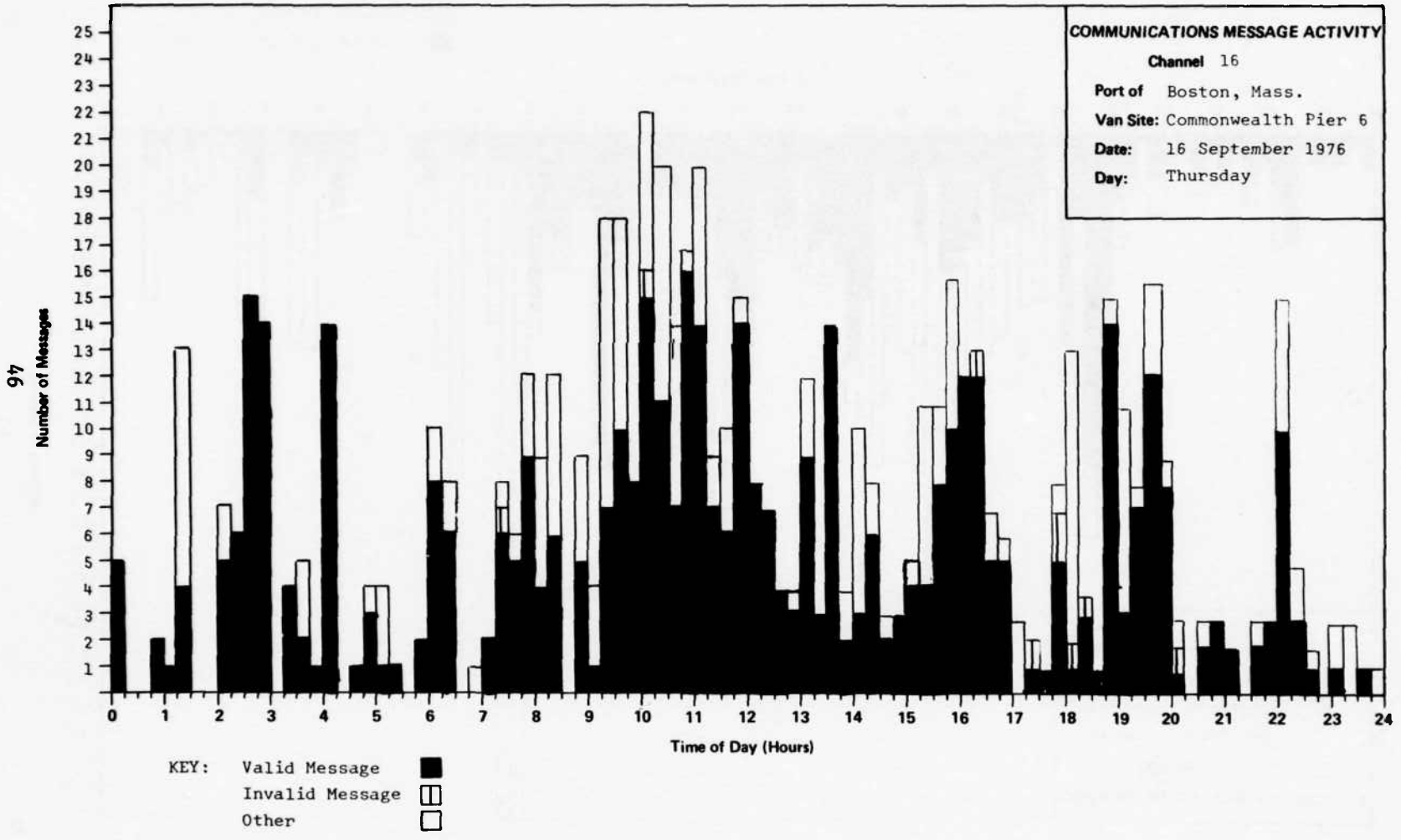

COMMUNICATIONS MESSAGE ACTIVITY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 16 September 1976
Day: Thursday
Number of Messages
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other

FIGURE 6-12

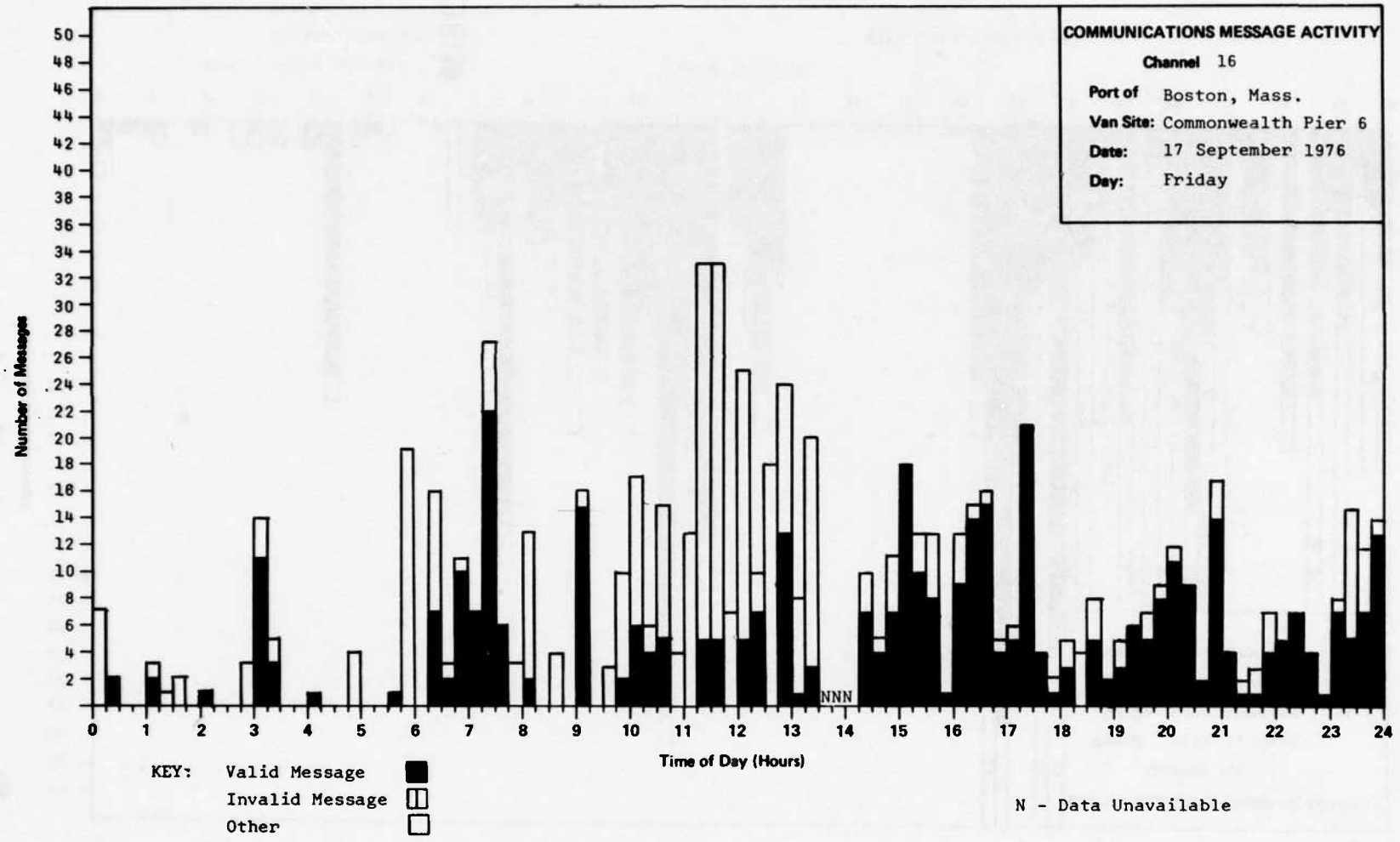

COMMUNICATIONS MESSAGE ACTIVITY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 17 September 1976
Day: Friday
Number of Messages
Time of Day (Hours)
NNN
KEY: Valid Message
Invalid Message
Other
N - Data Unavailable

FIGURE 6-13

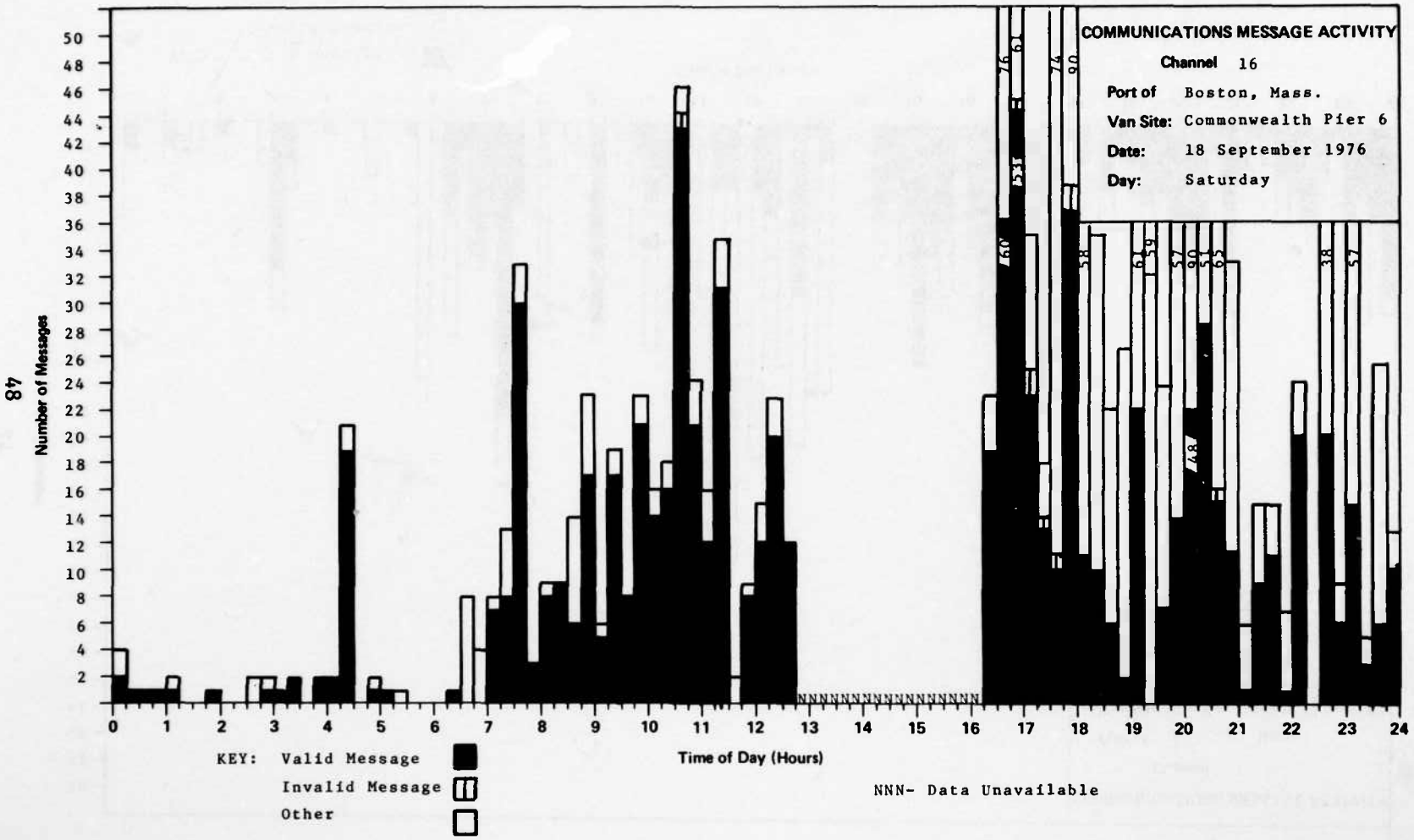

COMMUNICATIONS MESSAGE ACTIVITY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 18 September 1976
Day: Saturday
Number of Messages
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other
NNN- Data Unavailable

FIGURE 6-14

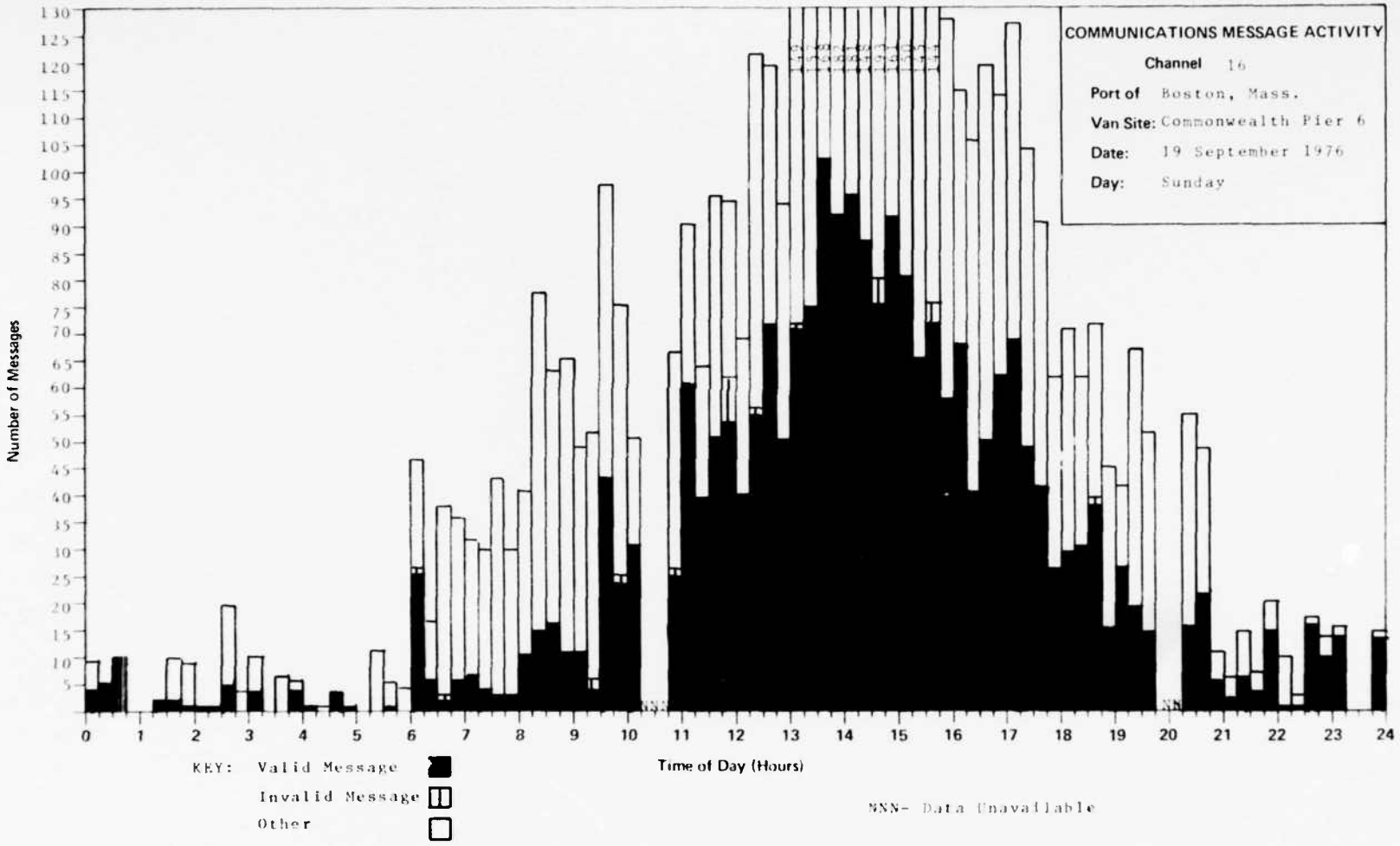

COMMUNICATIONS MESSAGE ACTIVITY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 19 September 1976
Day: Sunday
Number of Messages
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other
NNN- Data Unavailable

FIGURE 6-15

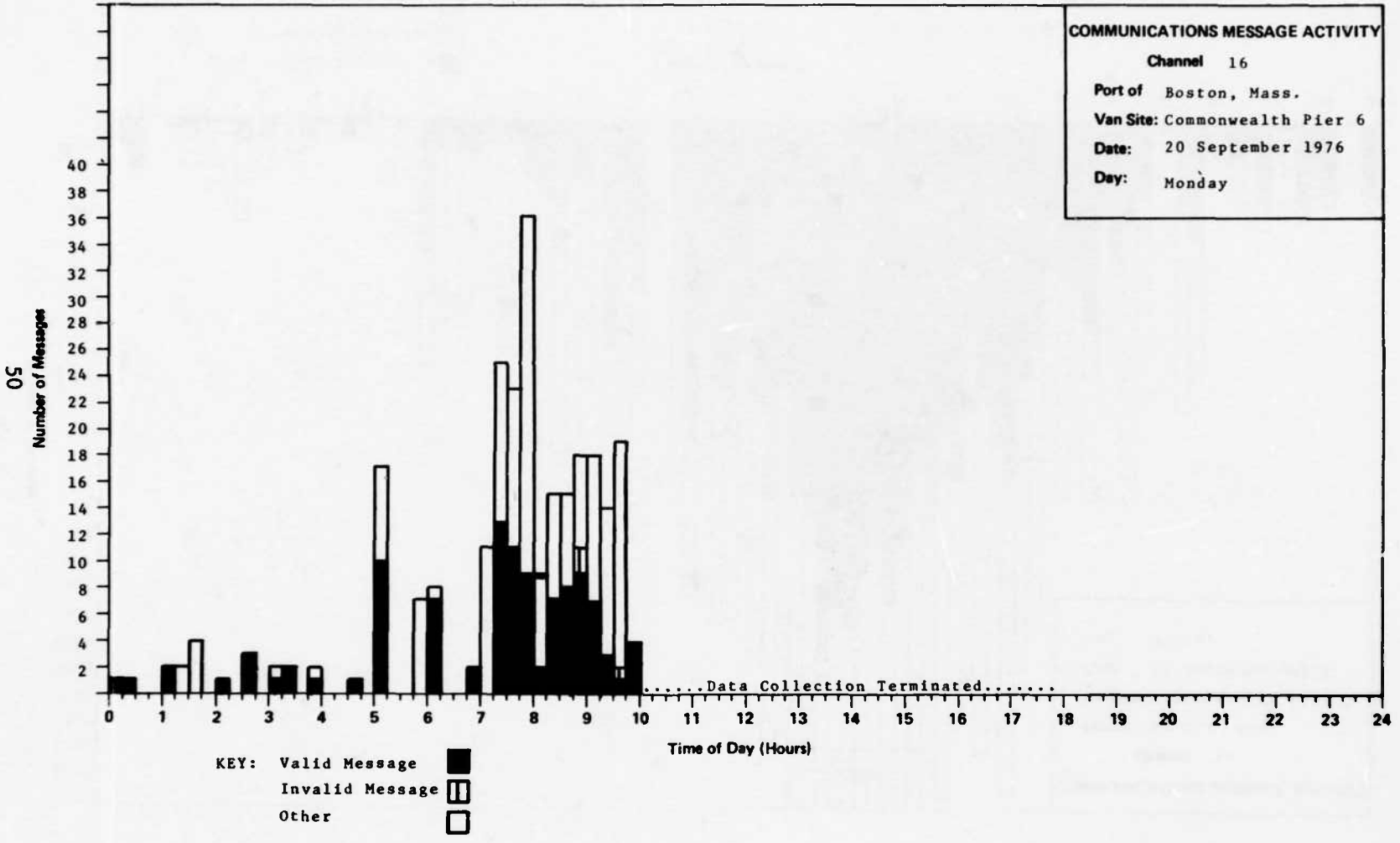

COMMUNICATIONS MESSAGE ACTIVITY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 20 September 1976
Day: Monday
Number of Messages
50
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
.....Data Collection Terminated.....
Time of Day (Hours)
KEY: Valid Message
Invalid Message
Other

FIGURE 6-16

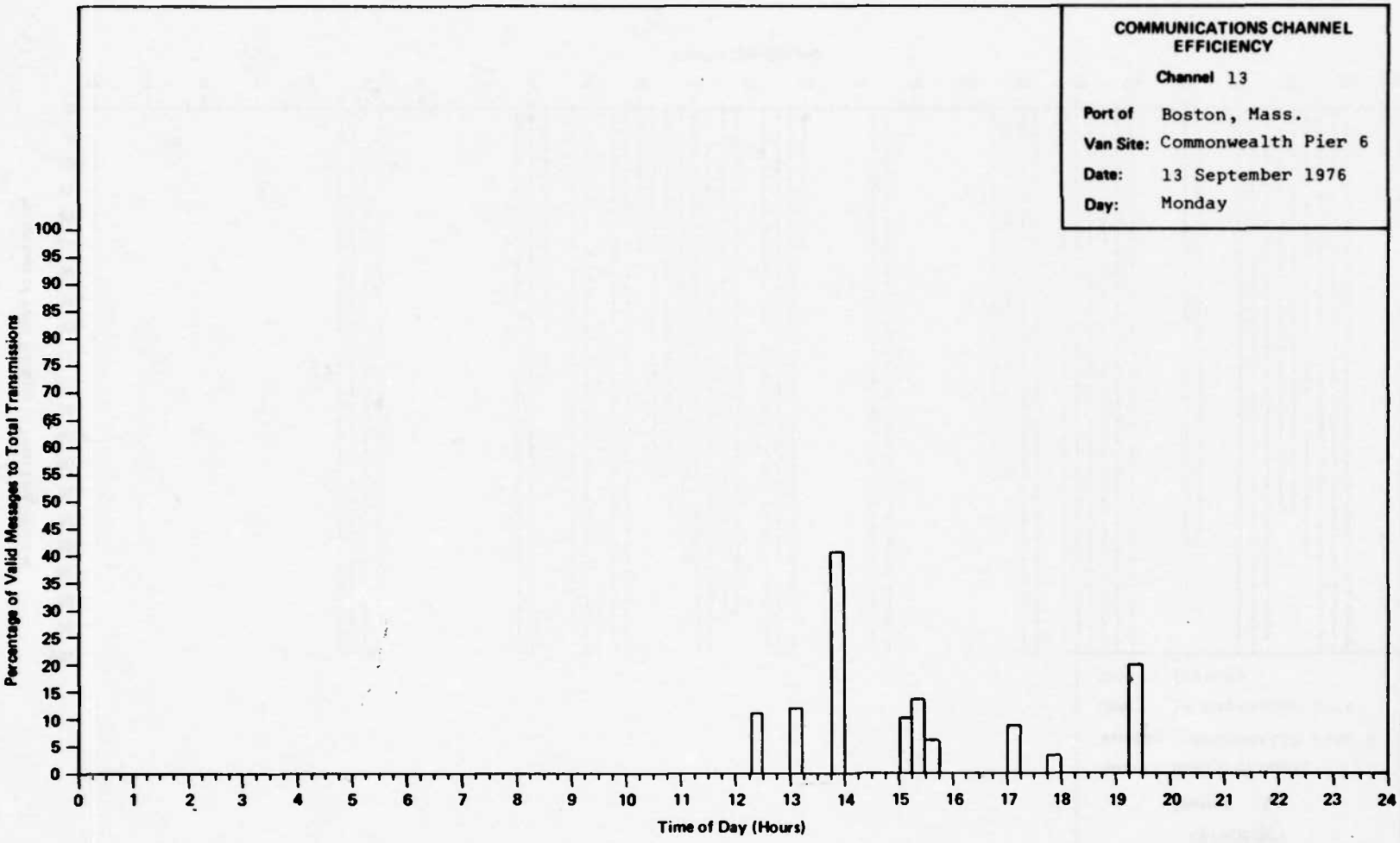

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 13 September 1976
Day: Monday
Percentage of Valid Messages to Total Transmissions
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day (Hours)

FIGURE 6-17

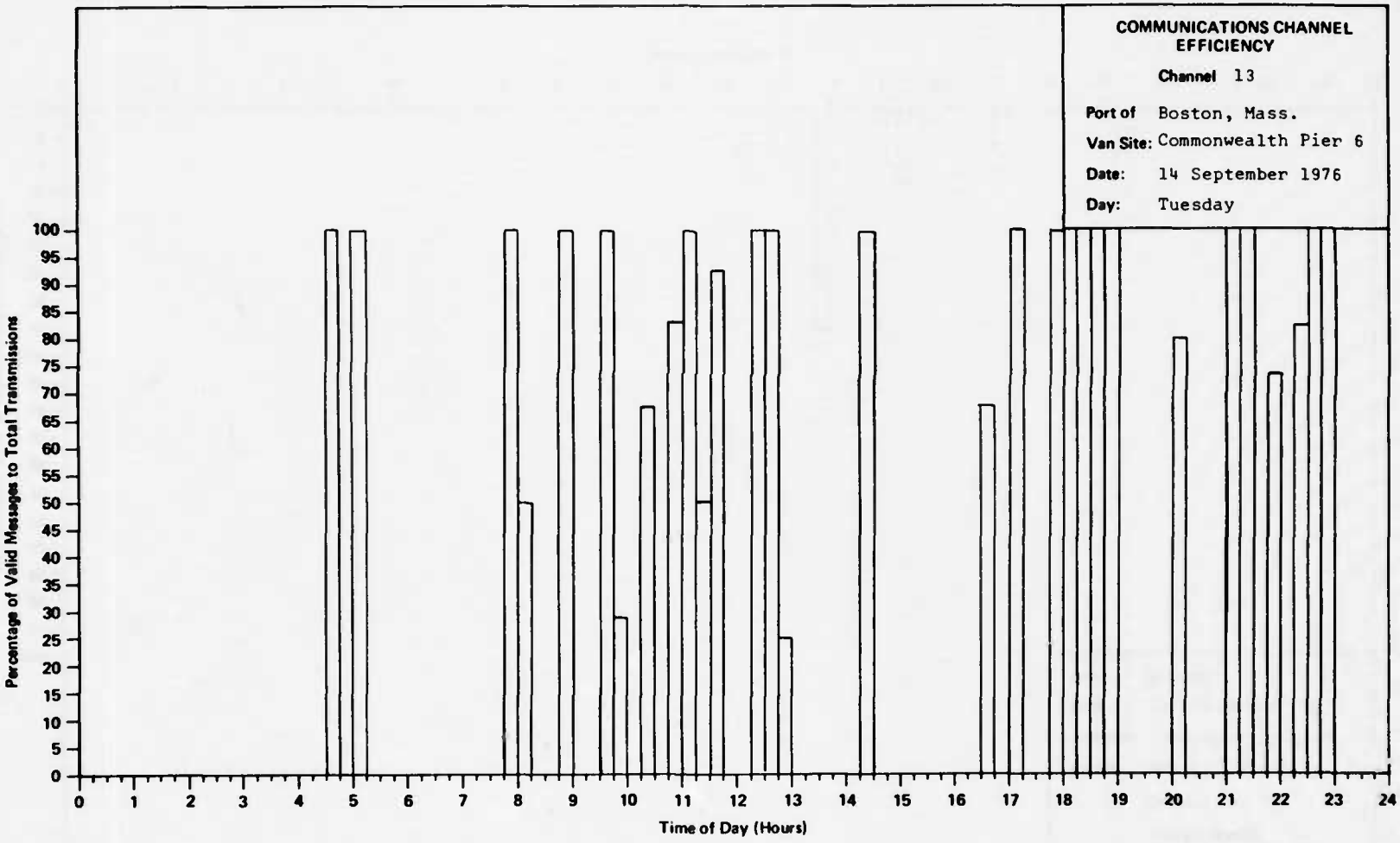

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 14 September 1976
Day: Tuesday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)

FIGURE 6-18

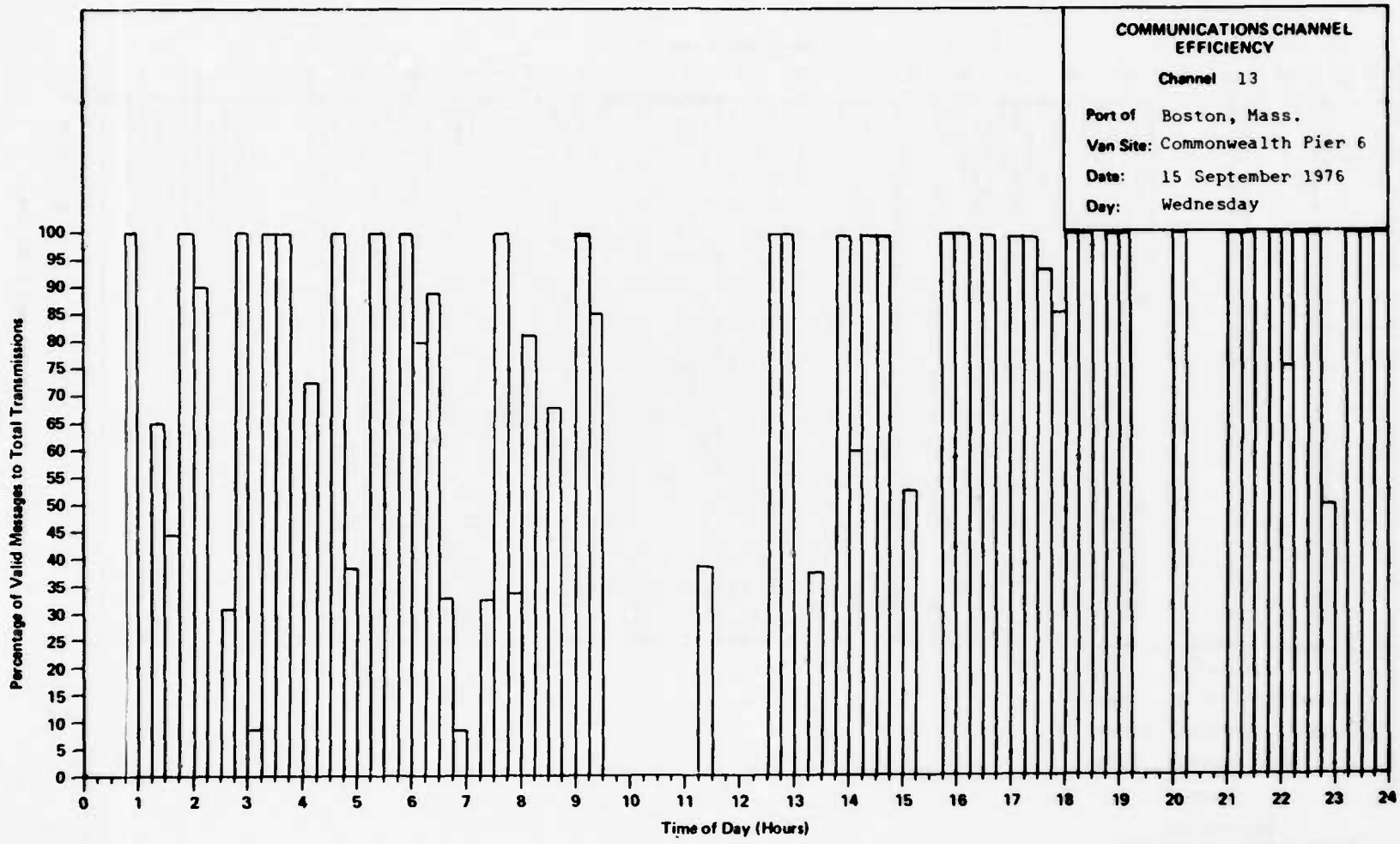

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 15 September 1976
Day: Wednesday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)

FIGURE 6-19

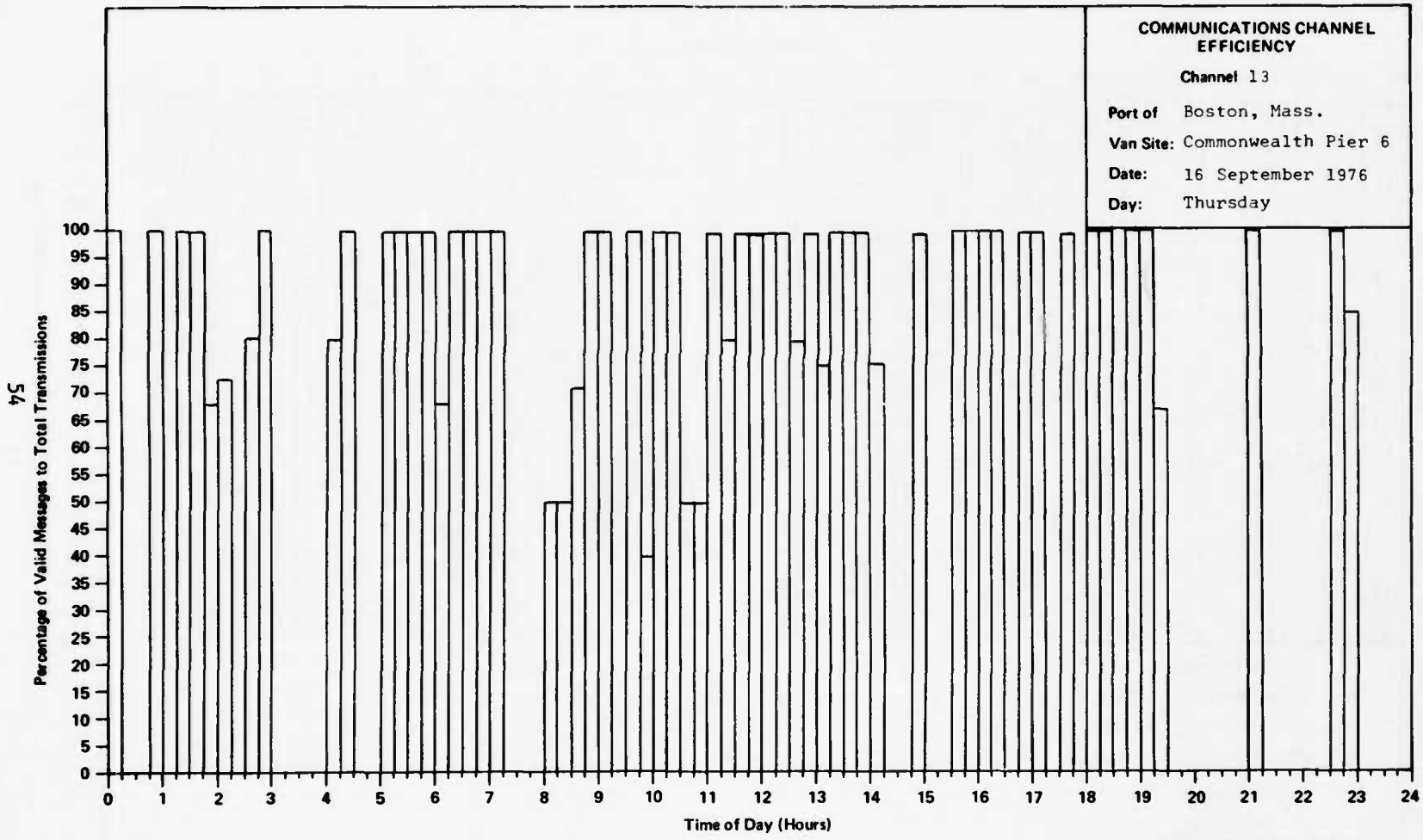

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 16 September 1976
Day: Thursday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 6-20

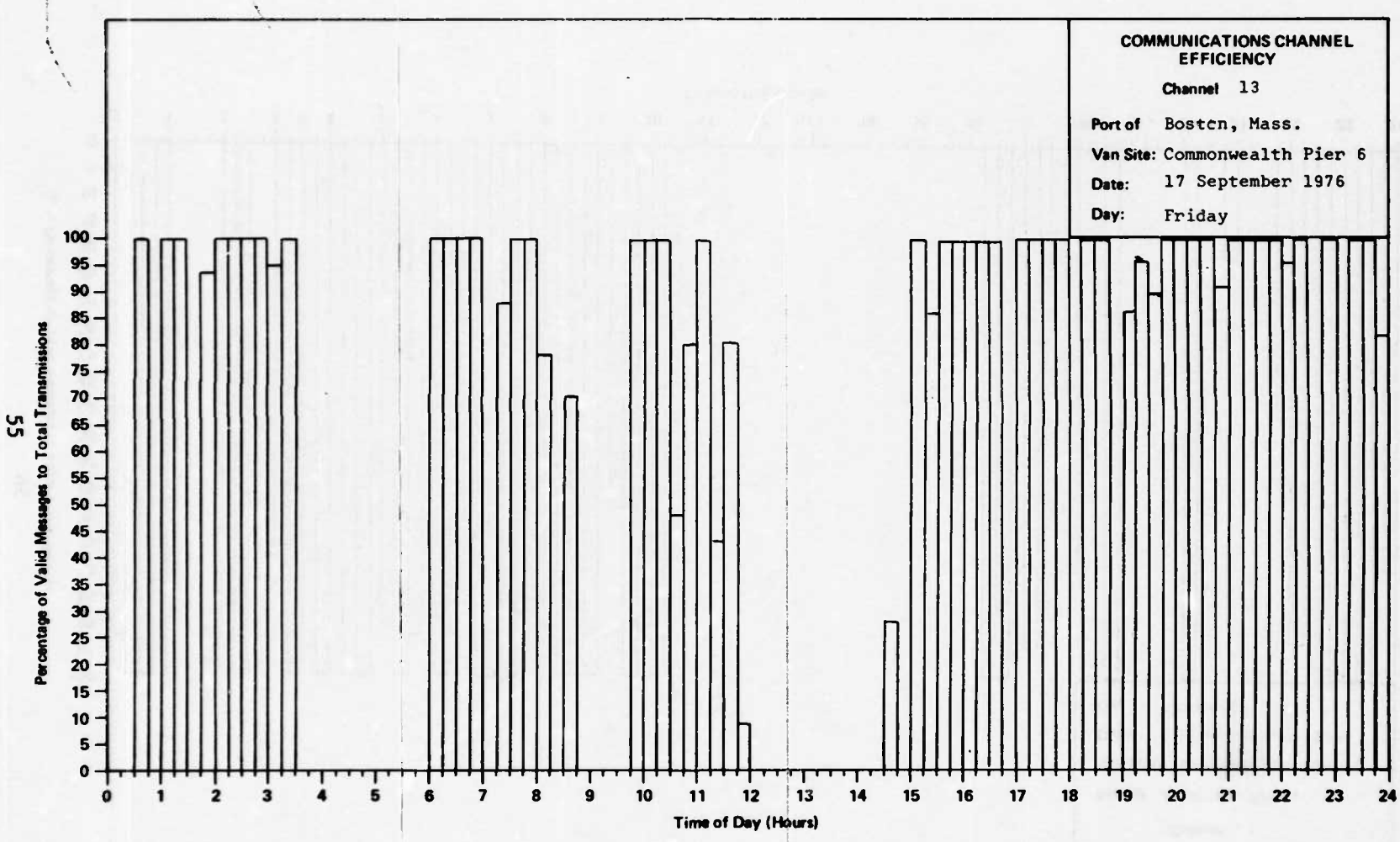

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 17 September 1976
Day: Friday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 6-21

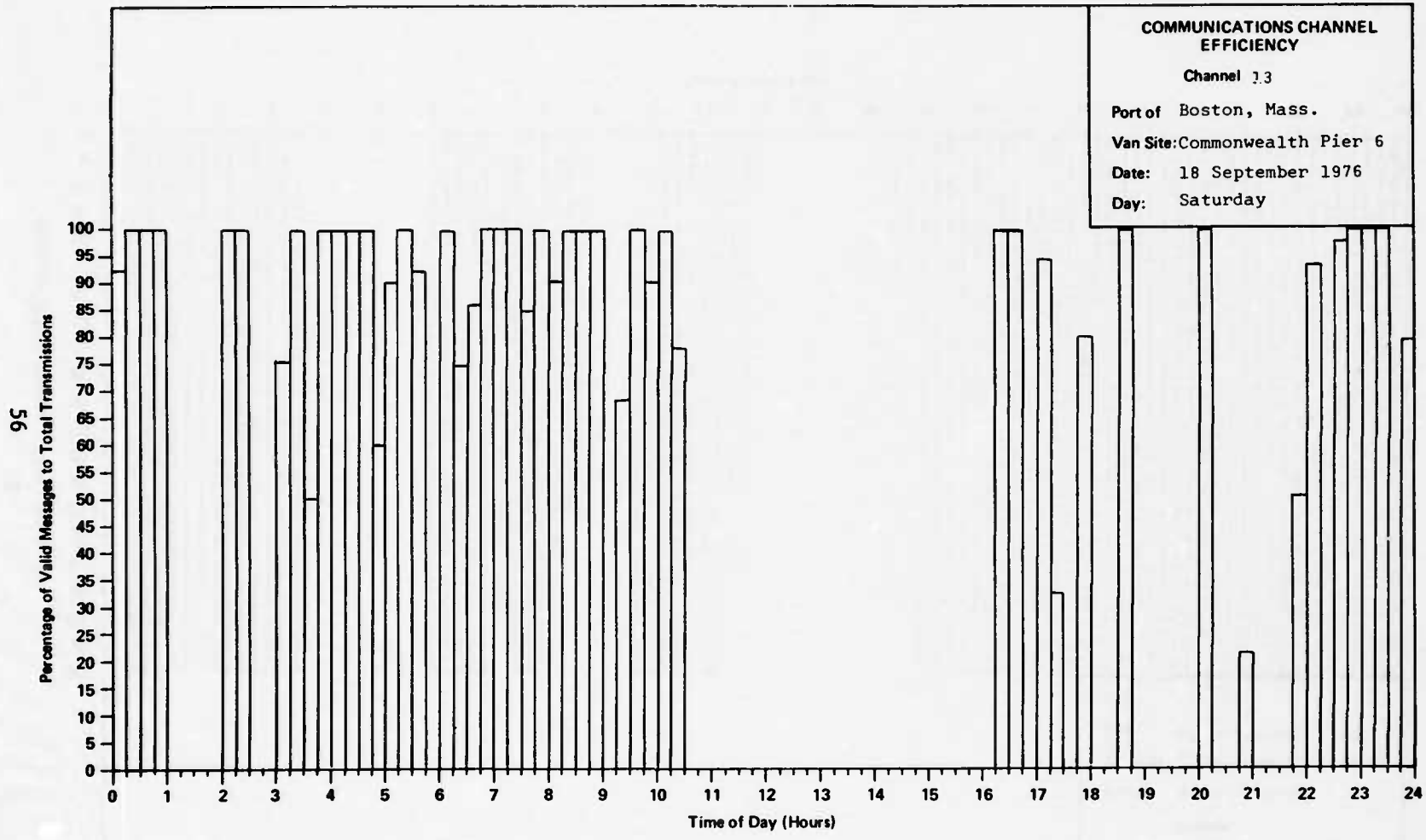

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 18 September 1976
Day: Saturday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 6-22

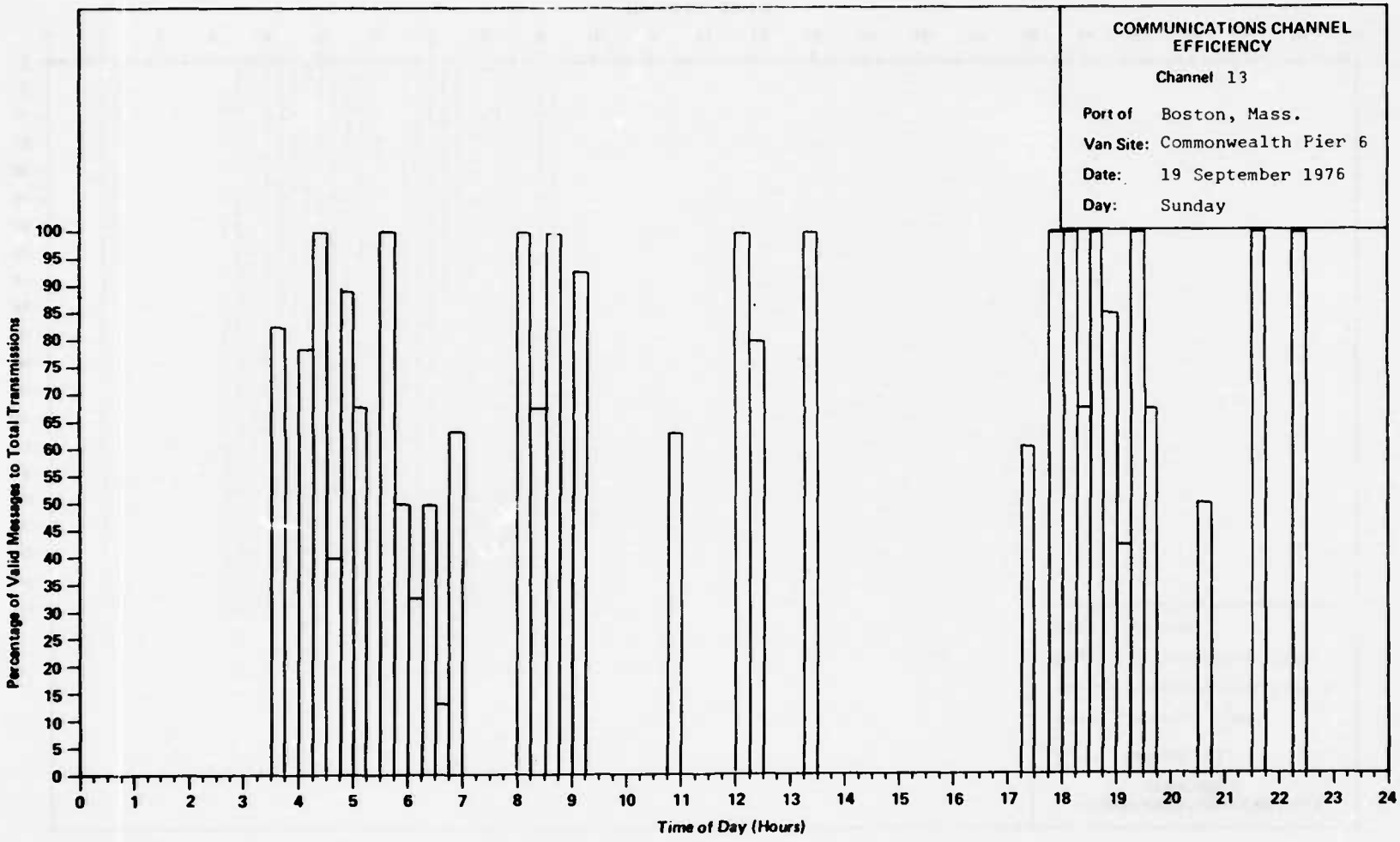

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 19 September 1976
Day: Sunday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)

FIGURE 6-23

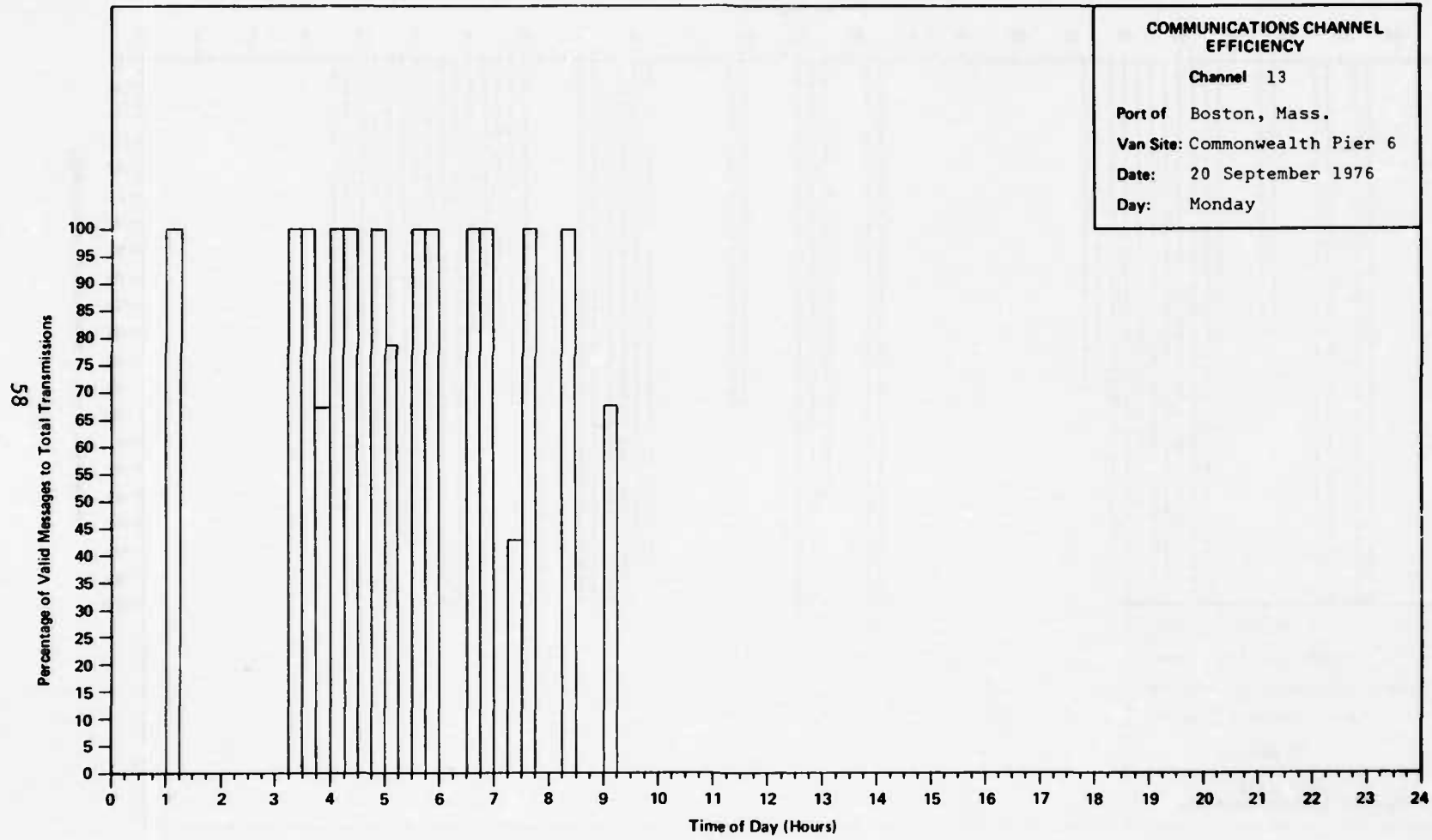

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 13
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 20 September 1976
Day: Monday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 6-24

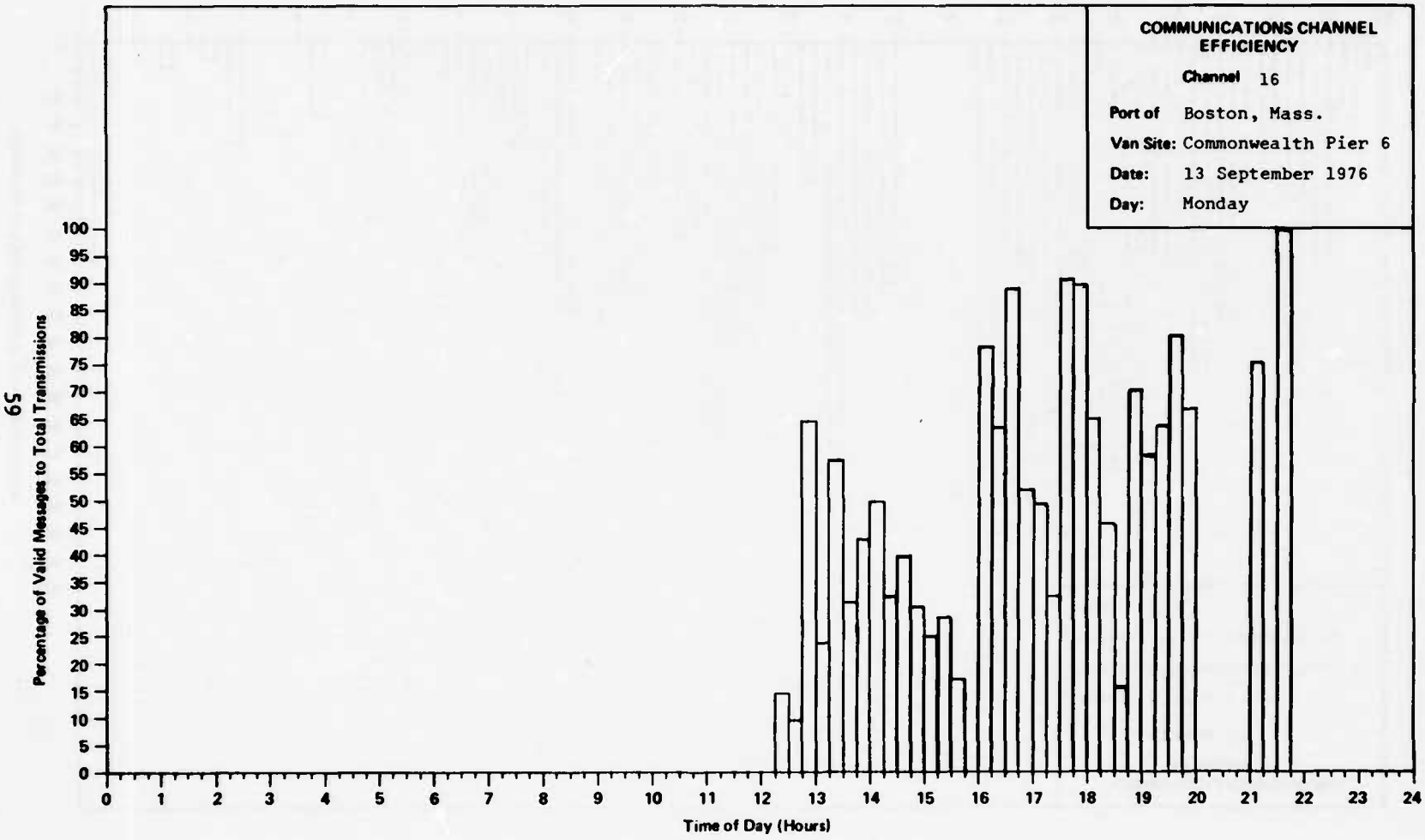

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 13 September 1976
Day: Monday
Percentage of Valid Messages to Total Transmissions
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day (Hours)

FIGURE 6-25

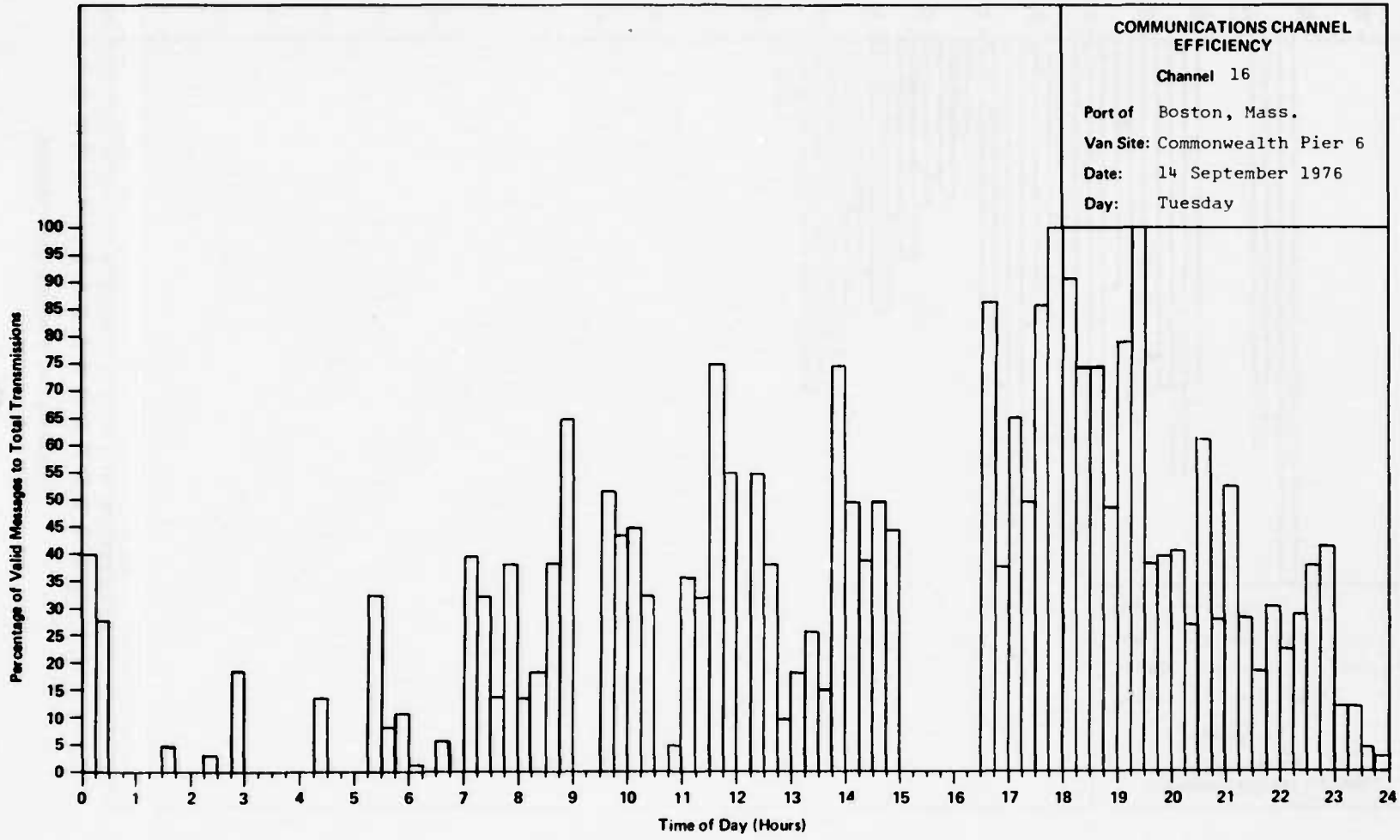

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 14 September 1976
Day: Tuesday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 6-26

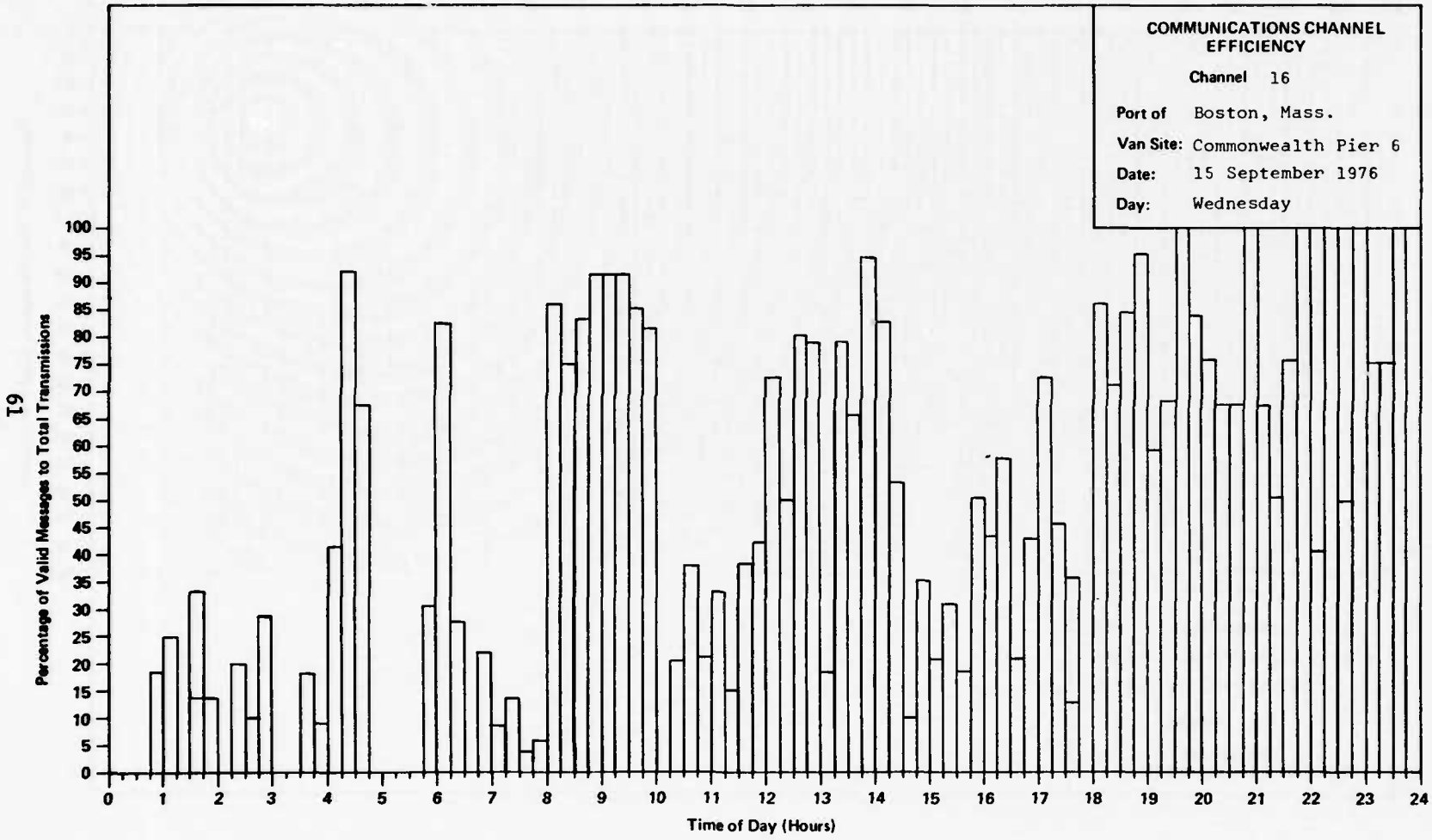

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 15 September 1976
Day: Wednesday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)

FIGURE 6-27

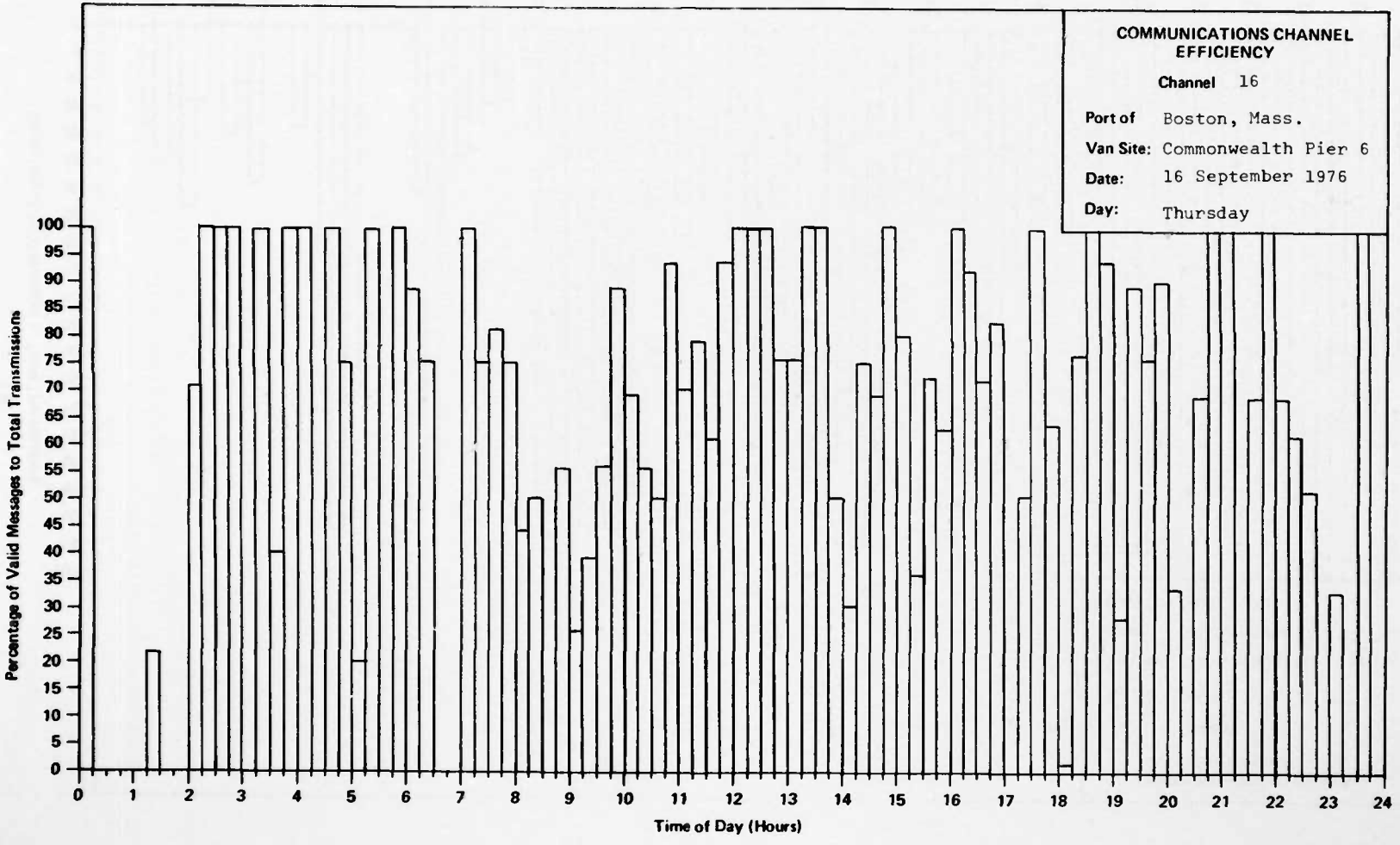

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 16 September 1976
Day: Thursday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)

FIGURE 6-28

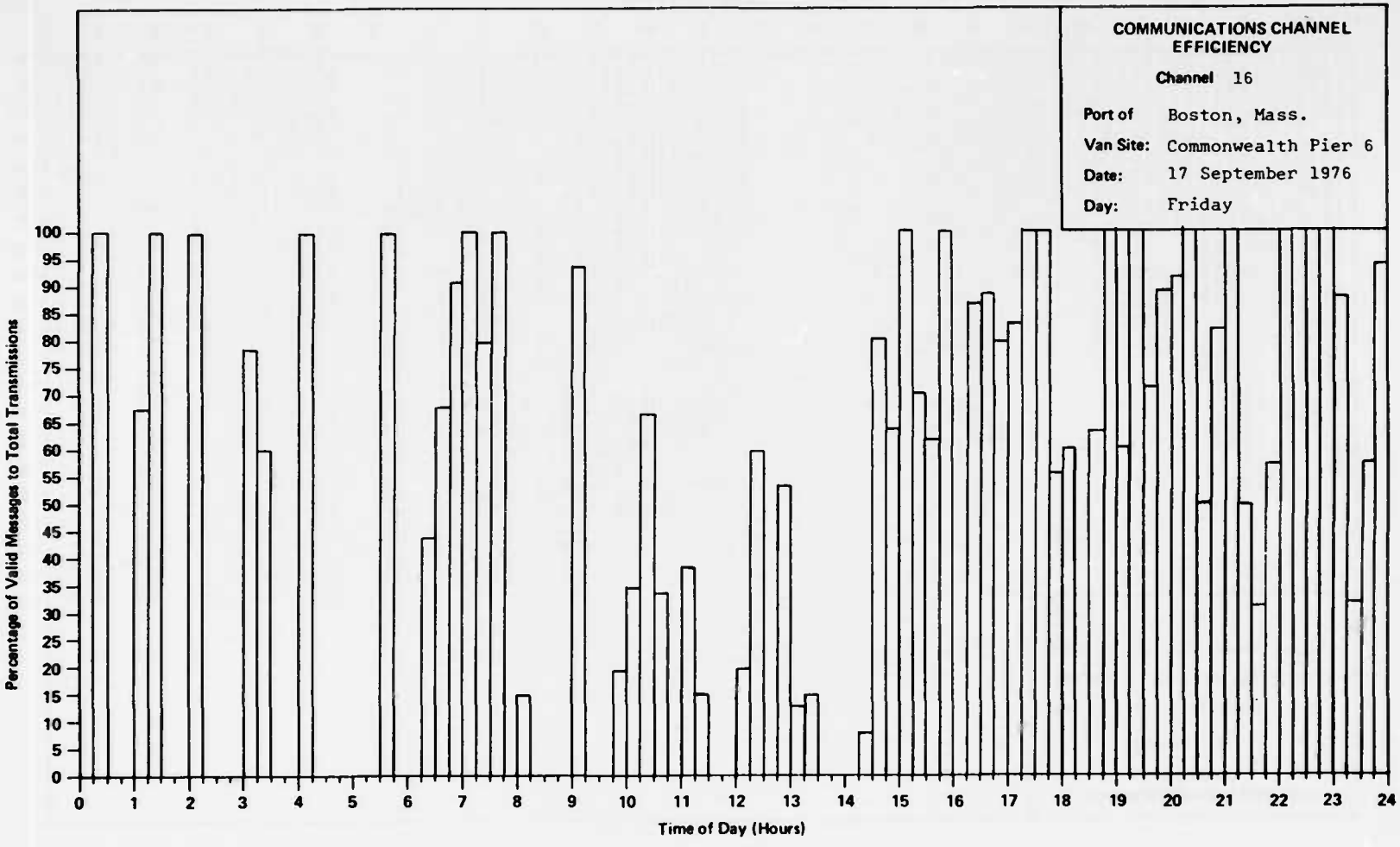

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 17 September 1976
Day: Friday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 6-29

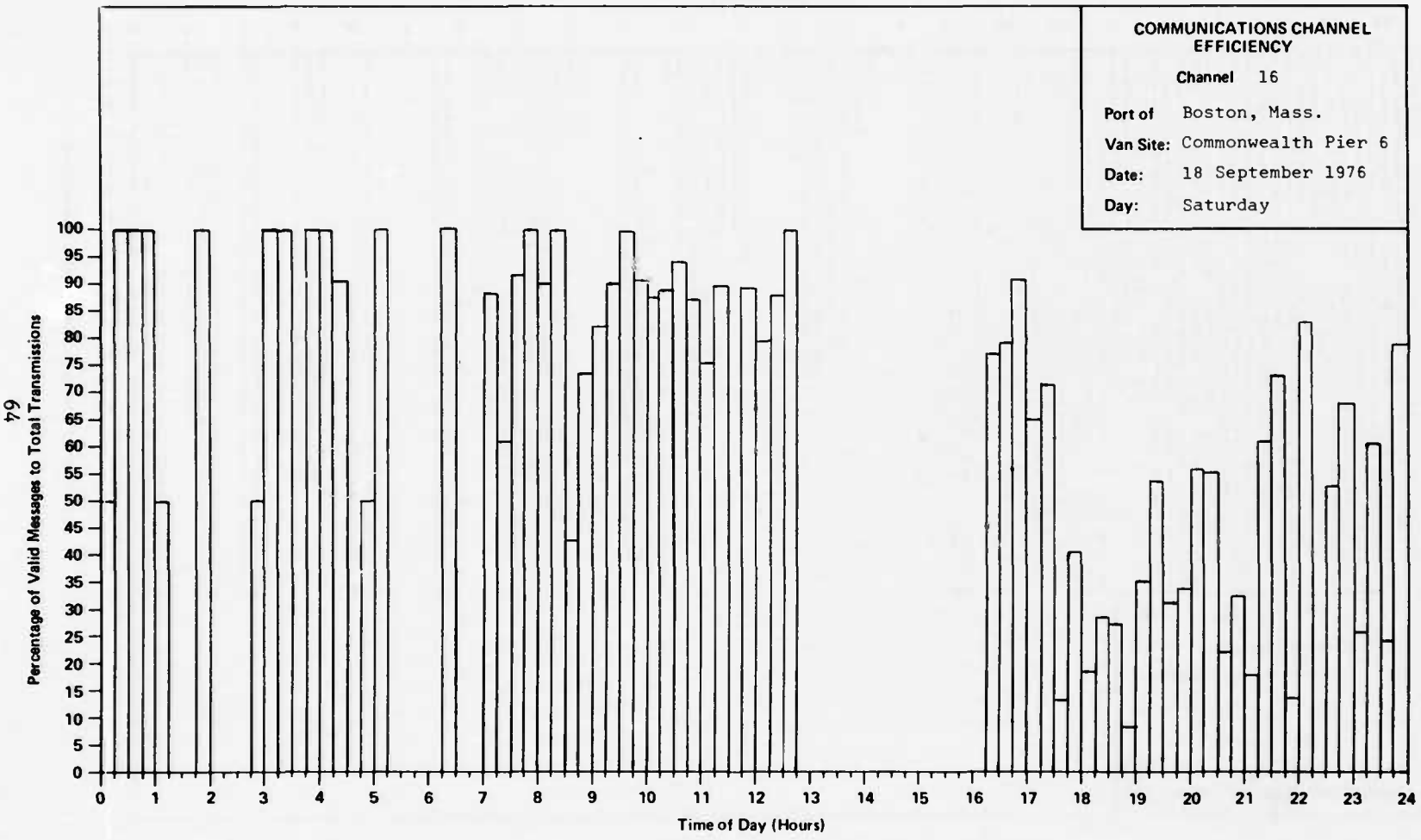

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 18 September 1976
Day: Saturday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 6-30

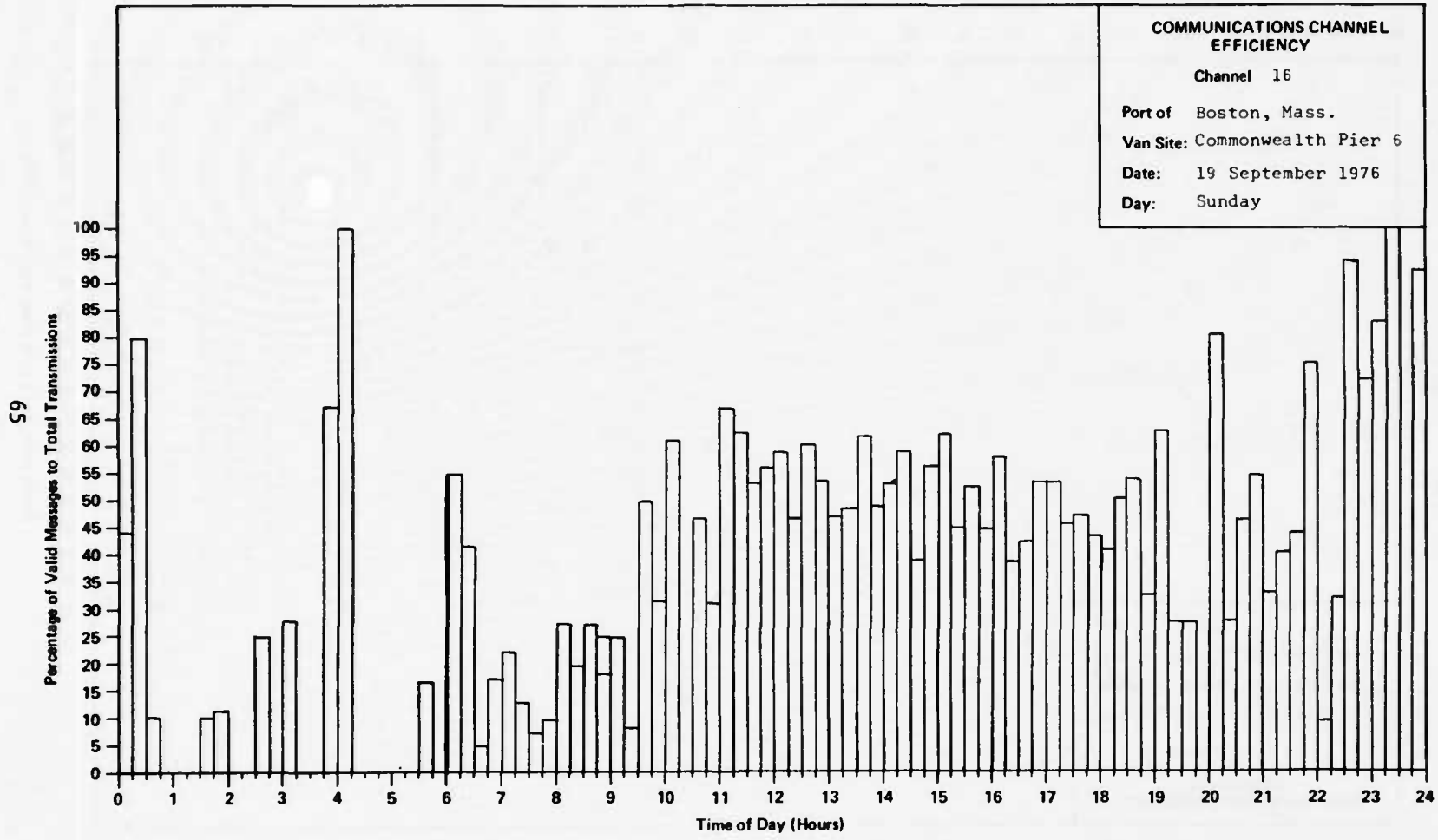

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 19 September 1976
Day: Sunday
Percentage of Valid Messages to Total Transmissions
Time of Day (Hours)

FIGURE 6-31

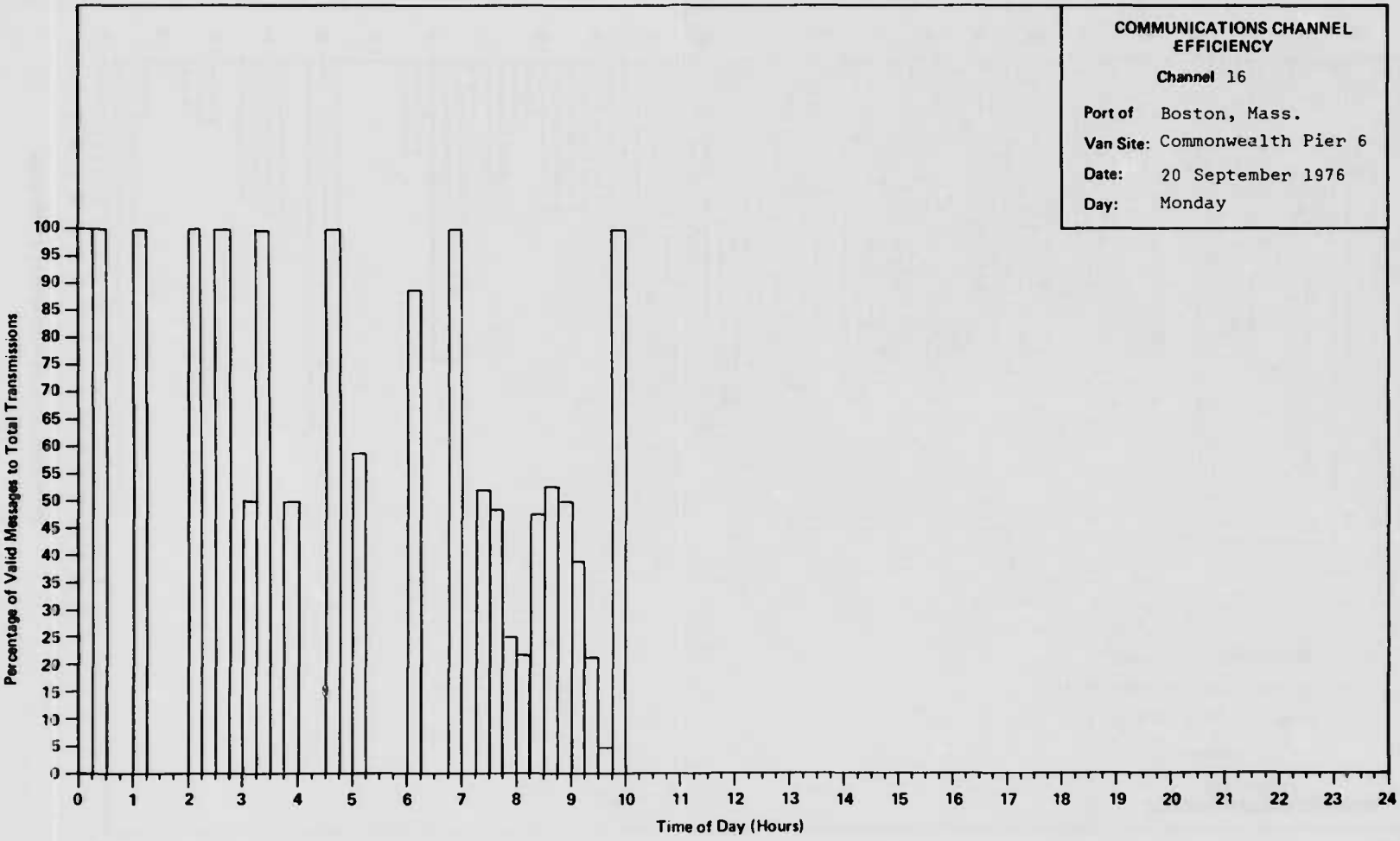

COMMUNICATIONS CHANNEL EFFICIENCY
Channel 16
Port of Boston, Mass.
Van Site: Commonwealth Pier 6
Date: 20 September 1976
Day: Monday
Percentage of Valid Messages to Total Transmissions
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time of Day (Hours)

FIGURE 6-32

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VHF-FM CH 13 XMSN STATISTICS

TRANSMISSION TIME HISTOGRAM

PERIOD ENDING:	NUMBER OF XMSNS:	MINUTES:	PERCENT:
15	3	0.08	0.53
30	0	0.00	0.00
45	0	0.00	0.00
100	1	0.01	0.08
115	0	0.00	0.00
130	0	0.00	0.00
145	0	0.00	0.00
200	0	0.00	0.00
215	0	0.00	0.00
230	0	0.00	0.00
245	1	0.04	0.23
300	3	0.04	0.29
315	0	0.00	0.00
330	0	0.00	0.00
345	0	0.00	0.00
400	0	0.00	0.00
415	0	0.00	0.00
430	9	0.37	2.43
445	2	0.21	1.38
500	0	0.00	0.00
515	1	0.00	0.00
530	3	0.23	1.50
545	7	0.54	3.57
600	0	0.00	0.00
615	2	0.18	1.19
630	3	0.07	0.47
645	0	0.00	0.00
700	11	0.24	1.61
715	28	1.12	7.49
730	0	0.00	0.00
745	5	0.13	0.89
800	3	0.10	0.63
815	4	0.08	0.56
830	0	0.00	0.00
845	5	0.04	0.27
900	12	0.19	1.23
915	0	0.00	0.00
930	11	0.59	3.91
945	0	0.00	0.00
1000	0	0.00	0.00
1015	10	0.19	1.25
1030	1	0.01	0.05
1045	4	0.15	1.00
1100	5	0.14	0.90
1115	1	0.03	0.21
1130	7	0.16	1.07
1145	11	0.33	2.21
1200	7	0.22	1.49

FIGURE 6-33

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PERIOD ENDING:	NUMBER OF XMSNS:	MINUTES:	PERCENT:
1215	0	0.00	0.00
1230	12	0.72	4.82
1245	9	0.27	1.77
1300	3	0.17	1.12
1315	0	0.00	0.00
1330	0	0.00	0.00
1345	0	0.00	0.00
1400	2	0.03	0.20
1415	0	0.00	0.00
1430	8	0.53	3.56
1445	0	0.00	0.00
1500	0	0.00	0.00
1515	0	0.00	0.00
1530	0	0.00	0.00
1545	0	0.00	0.00
1600	0	0.00	0.00
1615	0	0.00	0.00
1630	0	0.00	0.00
1645	2	0.01	0.37
1700	0	0.00	0.00
1715	2	0.18	1.18
1730	0	0.00	0.00
1745	0	0.00	0.00
1800	12	0.86	5.75
1815	1	0.04	0.23
1830	3	0.21	1.38
1845	0	0.00	0.00
1900	3	0.19	1.27
1915	61	0.39	2.57
1930	0	0.00	0.00
1945	3	0.04	0.28
2000	0	0.00	0.00
2015	6	0.18	1.19
2030	5	0.01	2.09
2045	0	0.00	0.00
2100	1	0.00	0.00
2115	4	0.16	1.08
2130	2	0.16	1.08
2145	0	0.00	0.00
2200	7	0.36	2.40
2215	11	0.78	5.20
2230	6	0.20	1.33
2245	5	0.30	2.01
2300	0	0.00	0.00
2315	0	0.00	0.00
2330	0	0.00	0.00
2345	0	0.00	0.00
2400	0	0.00	0.00

FIGURE 6-33 (Continued)

TOTAL NUMBER OF TRANSMISSIONS:	328
AVE. NUM. OF TRANSMISSIONS PER HOUR:	13.7
TOTAL TRANSMISSION TIME:	0.188 HOURS
AVERAGE LENGTH OF TRANSMISSION:	2.06 SEC.
PERCENT CHANNEL UTILIZATION:	0.78%

MESSAGE LENGTH HISTOGRAM

LENGTH OF XMSNS	NUMBER OF XMSNS	PERCENT
0.0 - 0.5 SEC.	124	37.81
0.5 - 1.0 SEC.	37	11.28
1.0 - 1.5 SEC.	38	11.59
1.5 - 2.0 SEC.	30	9.15
2.0 - 2.5 SEC.	13	3.96
2.5 - 3.0 SEC.	15	4.57
3.0 - 3.5 SEC.	10	3.05
3.5 - 4.0 SEC.	12	3.66
4.0 - 4.5 SEC.	8	2.44
4.5 - 5.0 SEC.	7	2.14
5.0 - 5.5 SEC.	4	1.22
5.5 - 6.0 SEC.	3	0.92
6.0 - 6.5 SEC.	4	1.22
6.5 - 7.0 SEC.	2	0.61
7.0 - 7.5 SEC.	1	0.31
7.5 - 8.0 SEC.	1	0.31
8.0 - 8.5 SEC.	5	1.53
8.5 - 9.0 SEC.	2	0.61
9.0 - 9.5 SEC.	2	0.61
9.5 - 10.0 SEC.	2	0.61
LONGER THAN 10 SEC.:	8	2.44

FIGURE 6-33 (Continued)

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VHF-FM CH 13 XMSN STATISTICS

TRANSMISSION TIME HISTOGRAM

PERIOD ENDING:	NUMBER OF XMSNS:	MINUTES:	PERCENT:
15	0	0.00	0.00
30	0	0.00	0.00
45	0	0.00	0.00
100	1	0.29	1.95
115	4	0.28	1.89
130	7	0.25	1.63
145	40	2.69	17.95
200	4	0.07	0.49
215	15	0.75	4.98
230	0	3.00	0.00
245	27	0.63	4.21
300	1	0.19	1.23
315	16	0.47	3.11
330	5	0.29	1.91
345	1	0.18	1.19
400	0	0.00	0.00
415	24	1.34	8.92
430	18	0.74	4.95
445	21	1.10	7.30
500	11	0.33	2.19
515	1	0.05	0.36
530	0	0.00	0.00
545	3	0.13	0.83
600	5	0.40	2.68
615	11	0.50	3.31
630	8	0.65	4.35
645	8	0.67	4.45
700	22	0.43	2.86
715	33	0.93	6.19
730	0	0.00	0.00
745	1	0.10	0.67
800	20	0.44	2.96
815	2	0.16	1.06
830	28	0.37	2.48
845	36	1.87	12.46
900	0	0.00	0.00
915	9	0.14	0.96
930	27	0.55	3.66
945	15	0.94	6.25
1000	0	0.00	0.00
1015	0	0.00	0.00
1030	14	0.23	1.50
1045	0	0.00	0.00
1100	1	0.00	0.02
1115	0	0.00	0.00
1130	3	0.21	1.41
1145	10	0.07	0.43
1200	11	0.08	0.56

FIGURE 6-34

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PERIOD ENDING:	NUMBER OF XMSNS:	MINUTES:	PERCENT:
1215	0	0.00	0.00
1230	0	0.00	0.00
1245	7	0.25	1.66
1300	9	0.16	1.03
1315	3	0.02	0.03
1330	6	0.13	0.83
1345	0	0.00	0.00
1400	0	0.00	0.00
1415	21	0.80	5.33
1430	6	0.59	3.90
1445	1	0.04	0.29
1500	4	0.02	0.12
1515	5	0.99	6.62
1530	3	0.07	0.43
1545	0	0.00	0.00
1600	0	0.00	0.00
1615	14	0.21	1.43
1630	0	0.00	0.00
1645	2	0.22	1.47
1700	7	0.10	0.63
1715	2	0.20	1.35
1730	4	0.35	2.32
1745	10	0.64	4.25
1800	20	0.86	5.73
1815	14	0.57	3.79
1830	15	0.44	2.91
1845	2	0.04	0.25
1900	4	0.17	1.11
1915	9	0.29	1.91
1930	0	0.00	0.00
1945	0	0.00	0.00
2000	0	0.00	0.00
2015	3	0.19	1.29
2030	0	0.00	0.00
2045	0	0.00	0.00
2100	0	0.00	0.00
2115	2	0.16	1.06
2130	6	0.20	1.33
2145	2	0.29	1.92
2200	1	0.13	0.85
2215	16	0.86	5.73
2230	8	0.48	3.19
2245	3	0.06	0.40
2300	6	0.35	2.35
2315	5	0.55	3.66
2330	19	1.54	10.25
2345	0	0.00	0.00
2400	25	2.11	14.09
2415	0	0.00	0.00

FIGURE 6-34 (Continued)

TOTAL NUMBER OF TRANSMISSIONS: 724
AVE. NUM. OF TRANSMISSIONS PER HOUR: 30.2
TOTAL TRANSMISSION TIME: 0.542 HOURS
AVERAGE LENGTH OF TRANSMISSION: 2.69 SEC.
PERCENT CHANNEL UTILIZATION: 2.26%

MESSAGE LENGTH HISTOGRAM

LENGTH OF XMSNS	NUMBER OF XMSNS	PERCENT
0.0 - 0.5 SEC.	235	32.46
0.5 - 1.0 SEC.	83	11.47
1.0 - 1.5 SEC.	47	6.49
1.5 - 2.0 SEC.	55	7.60
2.0 - 2.5 SEC.	50	6.91
2.5 - 3.0 SEC.	47	6.49
3.0 - 3.5 SEC.	37	5.11
3.5 - 4.0 SEC.	17	2.35
4.0 - 4.5 SEC.	23	3.18
4.5 - 5.0 SEC.	15	2.07
5.0 - 5.5 SEC.	10	1.38
5.5 - 6.0 SEC.	15	2.07
6.0 - 6.5 SEC.	20	2.76
6.5 - 7.0 SEC.	8	1.11
7.0 - 7.5 SEC.	7	0.97
7.5 - 8.0 SEC.	9	1.24
8.0 - 8.5 SEC.	3	0.42
8.5 - 9.0 SEC.	6	0.83
9.0 - 9.5 SEC.	5	0.69
9.5 - 10.0 SEC.	2	0.28
LONGER THAN 10 SEC.:	30	4.14

FIGURE 6-34 (Continued)

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VHF-FM CH 13 XMSN STATISTICS

TRANSMISSION TIME HISTOGRAM

PERIOD ENDING:	NUMBER OF XMSNS:	MINUTES:	PERCENT:
15	18	0.30	5.32
30	20	1.32	8.82
45	1	0.08	0.50
100	4	0.18	1.18
115	0	0.00	0.00
130	3	0.30	0.00
145	3	0.00	2.00
200	0	0.30	2.00
215	4	0.46	3.03
230	2	0.05	0.31
245	0	0.00	0.00
300	0	0.00	0.00
315	15	1.01	6.70
330	10	0.33	2.18
345	12	0.50	3.32
400	37	1.74	11.60
415	35	1.39	12.60
430	16	0.52	3.47
445	14	0.40	2.65
500	3	0.19	1.29
515	29	0.17	1.15
530	77	2.45	16.36
545	64	3.46	23.08
600	1	0.11	0.72
615	16	0.91	6.06
630	15	0.61	4.07
645	23	0.52	3.43
700	26	1.23	8.17
715	18	1.27	8.46
730	25	1.92	12.77
745	23	1.41	9.38
800	12	0.75	4.98
815	27	1.67	11.16
830	12	0.72	4.32
845	32	1.72	11.43
900	6	0.33	2.22
915	1	0.00	0.02
930	7	0.29	1.95
945	3	0.14	0.92
1000	48	1.50	9.99
1015	34	2.72	18.11
1030	22	0.41	2.75
1045	2	0.00	0.00
1100	0	0.00	0.00
1115	0	0.00	0.00
1130	9	0.11	0.71
1145	0	0.00	0.00
1200	3	0.00	0.00

FIGURE 6-35

PERIOD ENDING:	NUMBER OF XMSNS:	MINUTES:	PERCENT:
1215	0	0.00	0.00
1230	0	0.00	0.00
1245	0	0.00	0.00
1300	0	0.00	0.00
1315	0	0.00	0.00
1330	0	0.00	0.00
1345	0	0.00	0.00
1400	0	0.00	0.00
1415	0	0.00	0.00
1430	0	0.00	0.00
1445	0	0.00	0.00
1500	0	0.00	0.00
1515	0	0.00	0.00
1530	0	0.00	0.00
1545	0	0.00	0.00
1600	0	0.00	0.00
1615	0	0.00	0.00
1630	0	0.00	0.00
1645	17	1.11	7.42
1700	13	0.07	0.47
1715	21	1.21	8.07
1730	15	0.59	3.96
1745	19	1.58	10.50
1800	13	0.84	5.58
1815	0	0.00	0.00
1830	3	0.08	0.53
1845	0	0.00	0.00
1900	0	0.00	0.00
1915	0	0.00	0.00
1930	0	0.00	0.00
1945	1	0.01	0.09
2000	0	0.00	0.00
2015	1	0.08	0.55
2030	0	0.00	0.00
2045	1	0.01	0.07
2100	28	1.49	9.90
2115	0	0.00	0.00
2130	0	0.00	0.00
2145	0	0.00	0.00
2200	9	0.61	4.09
2215	10	0.95	6.30
2230	0	0.00	0.00
2245	29	1.61	10.70
2300	1	0.04	0.27
2315	31	2.84	18.93
2330	6	0.40	2.69
2345	2	0.01	0.06
2400	14	0.57	3.79
2415	0	0.00	0.00

FIGURE 6-35 (Continued)

TOTAL NUMBER OF TRANSMISSIONS:	964
AVE. NUM. OF TRANSMISSIONS PER HOUR:	40.2
TOTAL TRANSMISSION TIME:	0.799 HOURS
AVERAGE LENGTH OF TRANSMISSION:	2.98 SEC.
PERCENT CHANNEL UTILIZATION:	3.33%

MESSAGE LENGTH HISTOGRAM

LENGTH OF XMSNS	NUMBER OF XMSNS	PERCENT
0.0 - 0.5 SEC.	192	19.92
0.5 - 1.0 SEC.	94	9.75
1.0 - 1.5 SEC.	89	9.23
1.5 - 2.0 SEC.	88	9.13
2.0 - 2.5 SEC.	89	9.23
2.5 - 3.0 SEC.	61	6.33
3.0 - 3.5 SEC.	57	5.91
3.5 - 4.0 SEC.	51	5.29
4.0 - 4.5 SEC.	35	3.63
4.5 - 5.0 SEC.	38	3.94
5.0 - 5.5 SEC.	24	2.49
5.5 - 6.0 SEC.	26	2.70
6.0 - 6.5 SEC.	21	2.18
6.5 - 7.0 SEC.	10	1.04
7.0 - 7.5 SEC.	14	1.45
7.5 - 8.0 SEC.	12	1.25
8.0 - 8.5 SEC.	13	1.35
8.5 - 9.0 SEC.	5	0.52
9.0 - 9.5 SEC.	6	0.62
9.5 - 10.0 SEC.	5	0.52
LONGER THAN 10 SEC.:	34	3.53

FIGURE 6-35 (Continued)

BOSTON HARBOR, MASS. 9/18/76 PAGE 1 OF 3

VHF-FM CH 16 XMSN STATISTICS

TRANSMISSION TIME HISTOGRAM

PERIOD ENDING:	NUMBER OF XMSNS:	MINUTES:	PERCENT:
15	9	0.30	1.93
30	7	0.37	2.49
45	25	0.21	1.41
100	24	0.24	1.62
115	19	0.18	1.19
130	1	0.08	0.51
145	0	0.00	0.00
200	10	0.10	0.65
215	42	0.31	2.09
230	0	0.00	0.00
245	9	0.10	0.63
300	1	0.06	0.42
315	6	0.36	2.42
330	6	0.15	1.01
345	0	0.00	0.00
400	4	0.34	2.23
415	1	0.09	0.61
430	83	2.88	19.21
445	2	0.08	0.53
500	0	0.00	0.00
515	0	0.00	0.00
530	5	0.18	1.17
545	3	0.03	0.19
600	0	0.00	0.00
615	2	0.01	0.06
630	12	0.14	0.91
645	49	0.54	3.60
700	20	0.13	0.85
715	52	0.75	5.02
730	88	1.55	10.35
745	81	2.28	15.22
800	32	0.33	2.21
815	19	0.43	2.86
830	42	0.95	6.32
845	73	0.89	5.92
900	103	1.23	8.22
915	82	1.17	7.82
930	64	1.13	7.53
945	77	2.05	13.68
1000	44	1.35	8.98
1015	57	1.76	11.72
1030	34	1.57	10.49
1045	104	3.75	25.02
1100	103	2.09	13.93
1115	50	1.13	7.50
1130	88	2.07	13.81
1145	0	0.00	0.00
1200	33	0.67	4.46

FIGURE 6-36

BOSTON HARBOR, MASS. 9/18/76 PAGE 2 OF 3

PERIOD ENDING:	NUMBER OF XMSNS:	MINUTES:	PERCENT:
1215	52	1.80	11.97
1230	45	6.36	42.37
1245	0	0.00	0.00
1300	0	0.00	0.00
1315	0	0.00	0.00
1330	0	0.00	0.00
1345	0	0.00	0.00
1400	0	0.00	0.00
1415	33	0.54	3.62
1430	0	0.00	0.00
1445	0	0.00	0.00
1500	0	0.00	0.00
1515	0	0.00	0.00
1530	0	0.00	0.00
1545	0	0.00	0.00
1600	0	0.00	0.00
1615	58	1.37	9.15
1630	122	5.34	35.60
1645	224	5.40	36.02
1700	213	6.43	42.83
1715	147	2.37	13.30
1730	135	2.36	15.73
1745	193	3.97	26.46
1800	163	2.93	19.53
1815	143	2.13	14.50
1830	94	1.60	10.69
1845	49	1.05	7.21
1900	84	2.94	19.61
1915	106	2.70	18.01
1930	134	2.65	17.66
1945	56	3.91	26.03
2000	95	2.19	14.60
2015	174	4.40	29.36
2030	76	3.37	22.49
2045	131	2.62	17.48
2100	73	1.61	10.72
2115	12	0.27	1.77
2130	26	0.96	6.41
2145	22	1.29	8.59
2200	10	0.09	0.60
2215	30	1.23	8.53
2230	0	0.00	0.00
2245	56	1.06	7.09
2300	16	0.45	3.00
2315	107	2.35	15.66
2330	9	0.30	2.00
2345	43	0.45	2.99
2400	31	0.76	5.05

FIGURE 6-36 (Continued)

TOTAL NUMBER OF TRANSMISSIONS:	4583
AVE. NUM. OF TRANSMISSIONS PER HOUR:	191.0
TOTAL TRANSMISSION TIME:	1.385 HOURS
AVERAGE LEIGTH OF TRANSMISSION:	1.48 SEC.
PERCENT CHANNEL UTILIZATION:	7.86%

MESSAGE LENGTH HISTOGRAM

LENGTH OF XMISNS	NUMBER OF XMISNS	PERCENT
0.0 - 0.5 SEC.	2827	61.69
0.5 - 1.0 SEC.	468	10.21
1.0 - 1.5 SEC.	240	5.24
1.5 - 2.0 SEC.	155	3.38
2.0 - 2.5 SEC.	94	2.05
2.5 - 3.0 SEC.	79	1.72
3.0 - 3.5 SEC.	103	2.25
3.5 - 4.0 SEC.	77	1.68
4.0 - 4.5 SEC.	52	1.14
4.5 - 5.0 SEC.	83	1.81
5.0 - 5.5 SEC.	63	1.38
5.5 - 6.0 SEC.	52	1.14
6.0 - 6.5 SEC.	54	1.18
6.5 - 7.0 SEC.	40	0.87
7.0 - 7.5 SEC.	40	0.87
7.5 - 8.0 SEC.	35	0.76
8.0 - 8.5 SEC.	23	0.50
8.5 - 9.0 SEC.	16	0.35
9.0 - 9.5 SEC.	10	0.22
9.5 - 10.0 SEC.	15	0.33
LONGER THAN 10 SEC.:	57	1.24

FIGURE 6-36 (Continued)

APPENDIX A

SUMMARY OF COAST GUARD MARINE SAFETY OFFICE, BOSTON, RECORDS RELATING TO COMMERCIAL VESSEL MOVEMENT

For the past several years, the Coast Guard Marine Safety Office in Boston has kept brief records of the arrival, departure, berth, agent and destination of the commercial vessels using the Port of Boston. A portion of these records has been summarized in the following figures. Table A-1 is a listing by month, year, type and destinations (within the harbor) for the large commercial vessels utilizing Boston harbor. The destinations were listed by sector for the sake of simplicity. The boundaries of the sectors are shown in Figure A-1. Table A-2 is a list of the vessels that arrived in Boston while radar data was being obtained. Figure A-2 is a stylized sketch of Boston harbor wherein the width of the channels is proportional to the percentage of the large commercial vessels visiting Boston that traveled through them. This figure was based on the data for the first six months of 1976. As can be seen, a substantial fraction of the traffic travels to or from the extreme ends of the harbor.

TABLE A-1 VESSEL BERTHING DESTINATIONS

Source of data: Ship's Running Status Records from MSO, Boston
Key: Other - passenger, research vessel, fishing vessel, etc.
NA - data not available

DATE	SECTION	1	2	3	4	5	TYPE TOTAL	MONTHLY TOTAL
Jan 1974	Freighter	23	6	7	35	1	72	
	Tanker	23	3	Ø	11	41	78	
	Other	Ø	1	Ø	Ø	Ø	1	151
Feb 1974	Freighter	7	2	3	21	1	34	
	Tanker	12	1	1	2	21	37	
	Other	Ø	Ø	Ø	Ø	Ø	Ø	71
Mar 1974	Freighter	23	3	7	29	1	63	
	Tanker	22	4	Ø	12	38	76	
	Other	Ø	2	Ø	Ø	Ø	2	141
Apr 1974	Freighter	17	2	1Ø	25	Ø	54	
	Tanker	17	Ø	Ø	9	23	49	
	Other	Ø	2	Ø	Ø	Ø	2	105
May 1974	Freighter	24	3	8	23	1	59	
	Tanker	17	1	Ø	1Ø	24	52	
	Other	1	2	Ø	Ø	Ø	3	114
Jun 1974	Freighter	15	1	7	28	Ø	51	
	Tanker	15	Ø	Ø	7	23	45	
	Other	Ø	4	Ø	Ø	Ø	4	100
July 1974	Freighter	12	2	4	22	1	41	
	Tanker	11	Ø	1	1Ø	25	47	
	Other	Ø	2	Ø	Ø	Ø	2	90
Aug 1974	Freighter	13	Ø	5	26	Ø	44	
	Tanker	14	1	Ø	7	28	50	
	Other	Ø	2	Ø	Ø	Ø	2	96
Sep 1974	Freighter	16	1	7	2Ø	Ø	44	
	Tanker	1Ø	1	1	4	14	30	
	Other	2	4	Ø	Ø	Ø	6	80
Oct 1974	Freighter	13	2	3	31	Ø	49	
	Tanker	1	1	2	9	23	36	
	Other	Ø	Ø	Ø	Ø	Ø	Ø	85

Nov 1974	Freighter	12	1	3	27	Ø	43	
	Tanker	19	1	2	13	12	47	
	Other	Ø	1	Ø	Ø	Ø	1	91
Dec 1974	Freighter	11	Ø	2	13	3	29	
	Tanker	16	2	4	9	25	56	
	Other	Ø	Ø	Ø	Ø	Ø	Ø	85
Jan 1975	Freighter	1Ø	2	3	15	Ø	3Ø	
	Tanker	14	1	1	13	16	47	
	Other	Ø	Ø	Ø	Ø	Ø	Ø	77
Feb 1975	Freighter	1Ø	2	4	22	Ø	38	
	Tanker	14	3	2	6	25	5Ø	
	Other	Ø	Ø	Ø	Ø	Ø	Ø	88
Mar 1975	Freighter	9	1	4	24	Ø	38	
	Tanker	18	1	1	9	25	54	
	Other	1	Ø	Ø	Ø	Ø	1	93
Apr 1975	Freighter	11	1	4	24	Ø	4Ø	
	Tanker	13	Ø	Ø	9	22	44	
	Other	Ø	Ø	Ø	Ø	Ø	Ø	84
May 1975	Freighter	8	3	1	33	Ø	45	
	Tanker	13	Ø	Ø	7	23	43	
	Other	Ø	3	Ø	Ø	Ø	3	91
Jun 1975	Freighter	Ø	1	Ø	6	Ø	7	
	Tanker	7	Ø	Ø	5	2Ø	32	
	Other	Ø	2	Ø	Ø	Ø	2	41
Jul 1975 - Dec 1975	Data Not Available							
Jan 1976	Freighter	19	3	2	29	Ø	53	
	Tanker	11	Ø	Ø	18	34	63	
	Other	Ø	Ø	Ø	Ø	Ø	Ø	116
Feb 1976	Freighter	2Ø	9	Ø	16	1	46	
	Tanker	25	2	1	11	29	68	
	Other	1	Ø	Ø	Ø	1	2	116
Mar 1976	Freighter	17	Ø	Ø	3Ø	Ø	47	
	Tanker	27	1	Ø	8	36	72	
	Other	1	Ø	1	1	Ø	3	122
Apr 1976	Freighter	14	6	Ø	13	3	36	
	Tanker	13	5	Ø	14	3Ø	62	
	Other	Ø	2	Ø	Ø	1	3	101

May 1976	Freighter	23	2	1	22	1	49	
	Tanker	11	1	3	1Ø	2Ø	45	
	Other	1	3	Ø	Ø	1	5	99
Jun 1976	Freighter	18	2	4	25	2	51	
	Tanker	11	Ø	Ø	12	2Ø	43	
	Other	Ø	1	Ø	1	Ø	2	96
Jul 1976	Freighter	11	4	Ø	18	Ø	33	
	Tanker	13	2	Ø	11	18	44	
	Other	Ø	1	Ø	Ø	Ø	1	78
Aug 1976	Freighter	14	3	2	29	Ø	48	
	Tanker	9	Ø	Ø	12	14	35	
	Other	Ø	1	Ø	Ø	Ø	1	84
Sep 1976 (Until 9/2Ø)	Freighter	1Ø	Ø	1	21	1	33	
	Tanker	12	1	Ø	14	16	43	
	Other	Ø	1	Ø	Ø	Ø	1	77

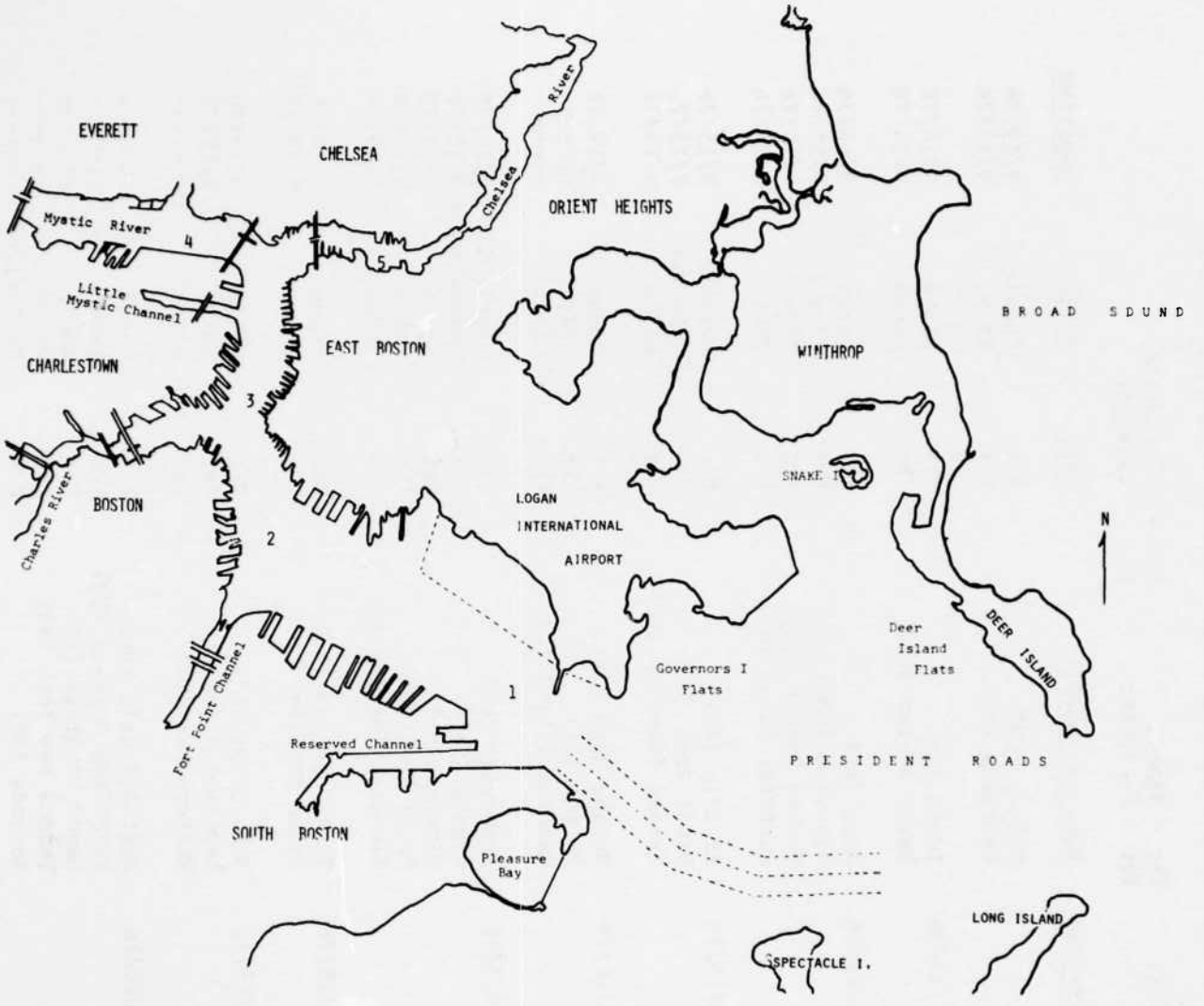

FIGURE A-1

BOSTON HARBOR

TABLE A-2 ARRIVALS AND DEPARTURES DURING RADAR DATA COLLECTION PERIOD

Source: Ship's Running Status Records from MSO, Boston

Key: Tkr - Tanker B/C - Bulk Carrier
Frt - Freighter Pas - Passenger

Arrived	Name of Vessel	Type	Berth	Departed
	Volnay (UK)	B/C	Castle I.	9/13/76
	Georgios (Gr)	Tkr	Anch. 2	9/13/76
9/13/76	Libra (Gr)	Tkr	Gibbs	9/14/76
	Exxon Boston (US)	Tkr	Exxon	9/14/76
9/14/76	Zeus (Br)	Frt	Moran	9/14/76
	Visevica (UGO)	Frt	Pier 1	9/15/76
	Mormac Dracoe (US)	Frt	Pier 1	9/16/76
	Austrial Pilot (US)	Frt	Pier 1	9/14/76
9/15/76	Arcadia (It)	Frt	Moran	9/15/76
	Mardi Gras (Pn)	Pas	Comm Pier	9/15/76
	Texaco Trinidad (Pn)	Tkr	White	9/16/76
9/16/76	Kuroba Maru (Ja)	Frt	Moran	9/19/76
	Pelion (Li)	Tkr	White	-------
	Radford Island (US)	Tkr	Citgo	-------
9/17/76	Anchorage (US)	Frt	Castle I.	9/18/76
	Cygnus (Gr)	Tkr	Metro/Union	9/18/76
	Minerva (Br)	Frt	Moran	9/18/76
	Mobil Fuel (US)	Tkr	Mobil	9/18/76
	Ilantila Iberia (Fr)	Frt	Moran	9/19/76
9/18/76	Tank Princess (No)	Tkr	Nepco	9/19/76
	Exxon Chester (US)	Tkr	Exxon	9/19/76
9/19/76	N.E. Scout (Li)	Frt	Moran	9/19/76
	Zephyros (Li)	Tkr	White	9/19/76
	Western Sun (US)	Tkr	Nepco	-------
9/20/76	Dart Atlantic (Br)	Frt	Moran	-------
	Exxon New Orleans (US)	Tkr	Exxon	-------
	Amoco Virginia (US)	Tkr	Amoco	-------
	Texaco New York (US)	Tkr	White	-------
	Koronda (SN)	Frt	Prolerized	-------

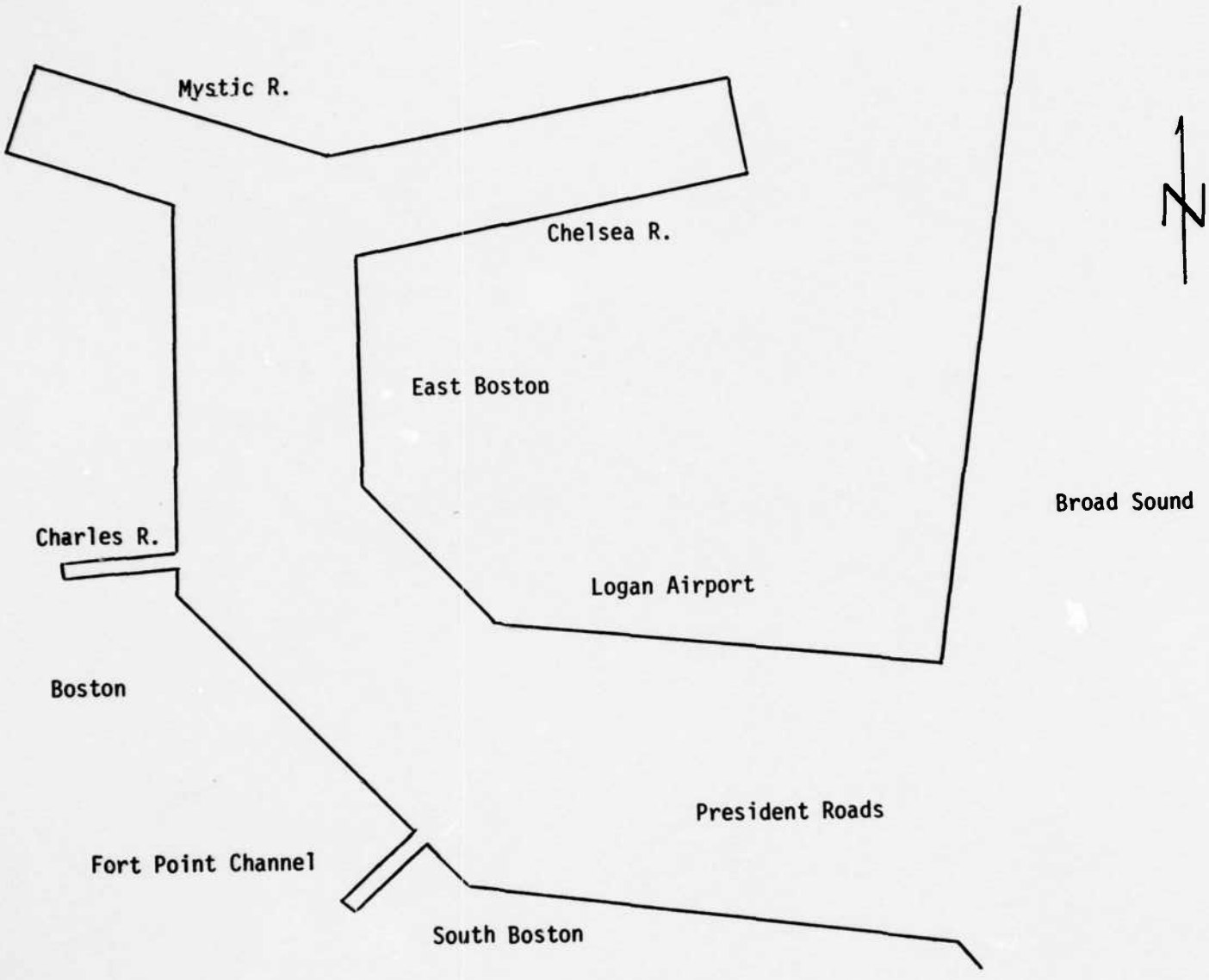

Figure A-2
STYLIZED SKETCH OF BOSTON HARBOR

APPENDIX B

DESCRIPTION OF THE BOSTON HARBOR AREA

The following description of the Boston harbor area was excerpted from the United States Coast Pilot, Volume 1, for 1973 and is included here to make this report more complete and more readily understandable. However, it should be noted that many of the commercial firms or government agencies mentioned in the Facilities section of this Appendix have moved to a different location within the harbor or have discontinued operations in the Boston area completely. Figure B-1, which is a sketch of the Boston harbor area, shows the present locations of the more prominent marine activities. The excerpt from the Coast Pilot follows:

Boston Harbor, the largest seaport in New England, includes all the tidewater lying within a line from the southern extremity of Deer Island to Point Allerton, about 4 miles to the southeastward. Numerous dangers lie in the approaches to the harbor. The northeastern approach is obstructed by islands and shoals which extend 4 miles from the entrance; between them are the dredged channels which lead into the harbor. In the southeastern approach, broken ground extends as muxh as 3 miles from the shore. The approaches are marked by a number of powerful lights, and the principal dangers are buoyed.

A Traffic Separation Scheme has been established in the approach to Boston Harbor, composed basically of directed traffic lanes each with one-way inbound and outbound traffic lanes separated by a defined separation zone and a precautionary area. The scheme is recommended for use by vessels approaching or departing from Boston Harbor, but is not necessarily intended for tugs, tows or other small vessels which traditionally operate outside the usual steamer lanes or close inshore.

The Traffic Separation Scheme has been designed to aid in the prevention of collisions at the approaches to major harbors, but is not intended in any way to supersede or alter the applicable rules of the road. Separation zones are intended to separate inbound and outbound traffic lanes and be free of ship traffic, and should not be used except for crossing purposes.

The precautionary area in the approach to Boston Harbor has a radius of 5 miles centered on the Boston Lightship (42°22'42"N. 70°47'00"W.). The inbound and outbound traffic lanes are a 2-mile wide lane each with a length of 127.5 miles. The separation zone is a 1-mile wide zone. The Traffic Separation Scheme is not buoyed.

PROMINENT FEATURES

Boston Lightship is moored about 7.8 miles east-northeastward of Deer Island. The vessel has a red hull with the name BOSTON in large white letters on the sides. A light, 53 feet above the water, is shown from

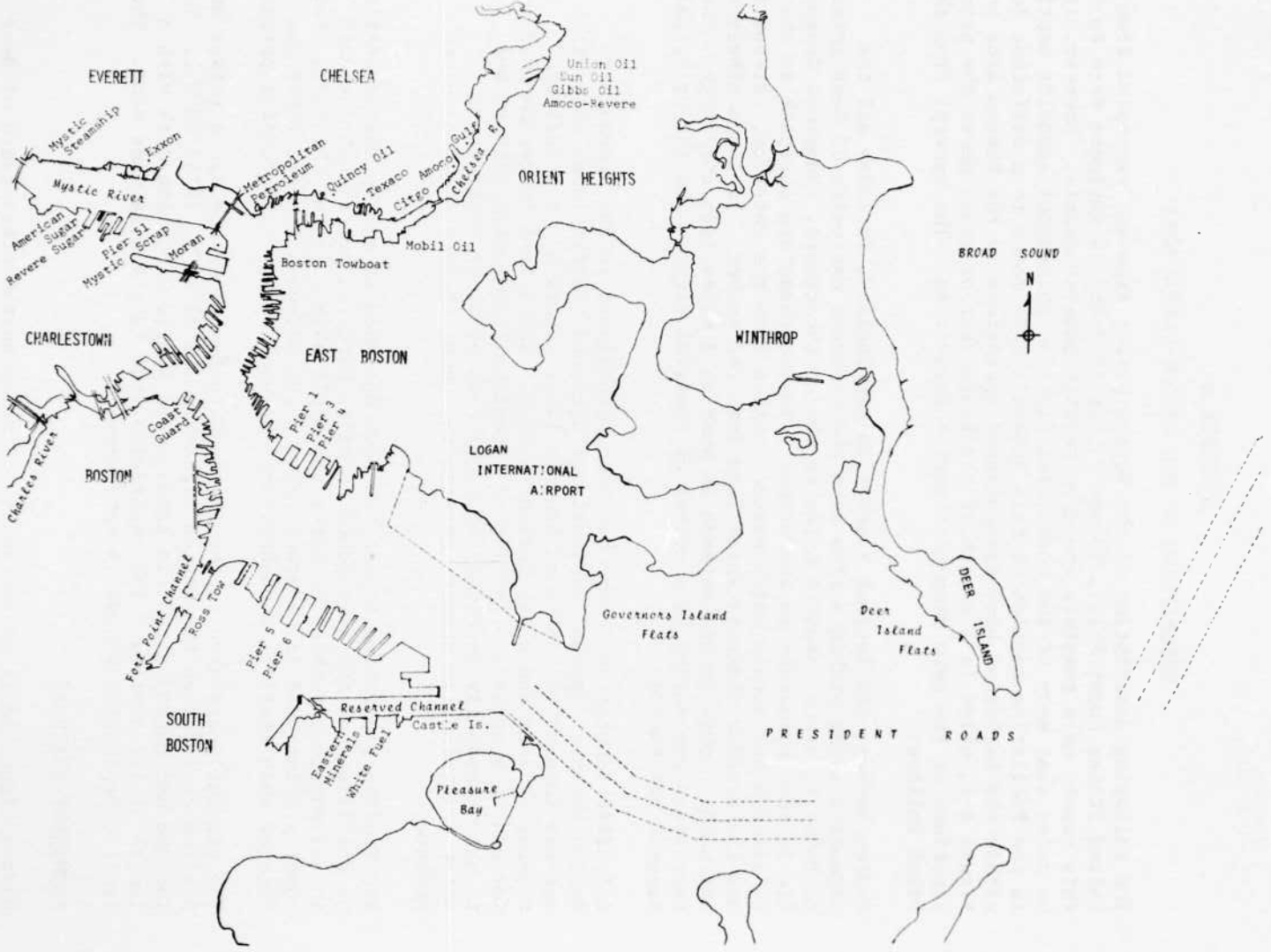

Figure B-1 SKETCH OF BOSTON HARBOR AREA

a single mast. A radiobeacon and fog signal are at the lightship. The code flag signal and radio call is NNBC. Storm warning signals are displayed during the daytime.

Conspicuous to a vessel approaching Boston Harbor from the northeastward is the tall standpipe on Winthrop Head. From eastward, the most prominent island in the entrance is Great Brewster. On the south side of the entrance, a turreted tower is conspicuous on Point Allerton; also prominent are the tank and standpipe on Strawberry Hill. Two miles south of Point Allerton are two radio towers which are illuminated at night.

The outstanding landmarks in the city are the John Hancock Building, the Prudential Building, the bridge over the Mystic River, the tower of the customhouse, and a large gas tank in Chelsea. Also prominent are the John F. Kennedy Federal Building in Boston, and a water tank and spire at Squantum.

BOSTON HARBOR

The main channel extends along the southern side of President Roads to the mouths of the Chelsea and Mystic Rivers, and to Charlestown Bridge on the Charles River. The channel has been dredged to 35 feet. It has been deepened to 40 feet for a 600-foot width from President Roads to the mouth of the Mystic River with a widening at the bend just north of Commonwealth Pier 5, South Boston.

The waters adjacent to the piers and wharves extending northward from Northern Avenue Bridge to and including Pier 4 along the Boston proper waterfront westward of the Boston Main Channel are nonnavigable owing to the redevelopment of this section of the waterfront.

ANCHORAGES

The anchorage on the north side of President Roads is the most commonly used general anchorage in Boston Harbor. The anchorage in Nantasket Roads, westward of the southern entrance to The Narrows, is good with depths up to 50-feet. The anchorage on the westerly side of Georges Island has depths up to 36-feet, better bottom, and is sheltered from easterly winds. This anchorage is frequently used by vessels seeking shelter in easterly gales.

TIDES AND CURRENTS

The mean range of tide is 9 feet at the entrance to Boston Harbor and 9.5-feet at Boston and Charlestown.

For some distance northwestward of Cape Cod the tidal currents have a slight set into Cape Cod Bay on the flood and out of the bay on the ebb. Along the north shore of Massachusetts Bay the flood sets in a general southwesterly direction and the ebb in a northeasterly direction. The

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velocity of the currents is influenced greatly be the force and direction of the wind. Off the entrance to Boston Harbor, the flood sets westward and the ebb eastward, increasing slightly in velocity as the entrance is approached.

In Broad Sound the velocity of the current at strength in most places is less than 0.8 knot. This increase to about 1 knot or more on approaching the entrances of the channels leading into Boston Harbor.

In Boston South Channel, north of Ram Head, the velocity at strength is almost 2 knots. In the channel between Deer Island Light and Long Island Head the velocity at strength is between 1 and 1.5. knots. The flood sets southwestward through the channel and the ebb northeastward.

Near the middle of the channel between Boston Light and Point Allerton the velocity at strength is about 1.5 knots. On the northern side of the channel southward of Great Brewster Spit the velocity is about half as great. In the middle of the channel in Nantasket Roads the velocity at strength is about 1.5 knots. In Nantasket Gut the velocity at strength is about 2.5 knots.

Between Georges Island and Gallps Island the velocity at strength is about 0.7 knot. The flood sets westward and the ebb northeastward.

Between Gallps Island and Long Island Head the velocity at strength is about 1 knot. The flood current sets southward to southwestward and the ebb northeastward.

Between Moon Head and Long Island, the current is rotary, turning counter-clockwise. The average velocity at strength is about 0.2 knot. Usually, strength of flood sets southwestward and strength of ebb eastward. Between Thompson Island and Spectacle Island the velocity at strength is about 0.5 knot. The flood sets northwestward and the ebb southeastward.

In Boston Main Channel from Spectacle Island to the Navy Yard the velocity at strength varies between 0.5 and 1 knot.

WEATHER

Boston has no dry season. For most years the longest run of days with no measurable precipitation does not extend much more than 2 weeks. This "dry spell" may occur at any time of year.

Heavy fog occurs on an average of about two days per month with its prevalence increasing eastward from the interior of Boston Bay to the open waters beyond. Winds from the east to southwest bring fog while westerly and northerly winds clear it away.

At all seasons the heaviest gales are usually from the northeastward or eastward. Although winds of 32 miles per hour or higher may be expected on at least one day in every month of the year, gales are both more common and more servere in winter.

AD-A047 153 COAST GUARD RESEARCH AND DEVELOPMENT CENTER GROTON CONN F/G 15/5
MARINE TRAFFIC DATA FOR THE PORT OF BOSTON.(U)
JAN 77 J A MCINTOSH, J J CHERNY, D E WATSON

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ICE

The channels of Boston Harbor are navigable throughout the year, ice rarely forming in the main channel. Occasionally during severe winters the greater part of the harbor is frozen, but towboats and steamers keep the main channels open. The Charles, Mystic and Chelsea Rivers and the minor passages in the harbor sometimes are frozen during severe winters. They are almost invariably kept open, however, by tugboat traffic. When ice is prevalent, the buoys may be displaced or even carried away. Local towboats can be employed for breaking ice.

APPROACHES

Boston Harbor and approaches have very broken rocky bottom, and caution is required.

The soundings in the vicinity of Cape Ann are very irregular and cannot be depended on to locate even approximately the vessel's position. A 228° course from 0.2 mile off the lighted whistle buoy, 2.5 miles eastward of Cape Ann Light, clears the offshore dangers between Cape Ann and Nahant, and leads close to the lighted gong buoy marking the entrance to Boston North Channel.

At night the lighted aids are sufficiently numerous to locate the position by cross bearings. In clear weather the course should be shaped to pass well northward of The Graves Light and enter through Boston North Channel.

Approaching the easterly side of the cape, soundings of 20-fathoms indicate a distance of 3 to 3.5 miles from shore, but off the north side of the cape, the 20-fathom curve draws closer inshore and the soundings are not so regular. Vessels standing to clear Boston Lightship on a course of 297° from the locality of Peaked Hill Bar Lighted Whistle Buoy 2 PH will cross the southwesterly end of Stellwagen Bank in depths of 12 to 15 fathoms. Soundings on Stellwagen Bank cannot be depended on to locate a position, except near the extreme southwest end of the bank where the shoalest depth of 10-fathoms is found. The recommended route, however, for deep-draft vessels is via the Boston Traffic Separation Scheme.

As the entrance to Boston Harbor is approached, after crossing Stellwagen Bank, soundings of 20-fathoms or more insure a distance of at least 5 miles from the shore and well outside of outlying rocks. Inside the depths of 20-fathoms, the soundings are very irregular and cannot be depended upon as a rule to keep a vessel out of danger. Northeast of Nahant the 20-fathom curve runs closer inshore and some of the dangers extend offshore nearly to the curve.

In approaching Boston Lightship from the southward, the coast from Scituate to Minots Ledge Light should be given a berth of 4 miles to avoid the broken ground of Stellwagen Ledges.

VOLUNTARY VESSEL REPORTING AND MOVEMENT PLAN

On 16 December 1971, the New England Water Traffic Separation Conference, a committee comprised of marine industry and Coast Guard members, voted to adopt a voluntary reporting and movement plan as outlined below for Boston Harbor in the interest of promoting the safe movement of vessels in the area.

Boston Tow Boat Company, because of it uniqueness in having dispatchers on duty 24 hours a day and maintaining radio and telephone contact with the pilots and other operational services within the harbor, has volunteered to accept and record the information on an advisory basis assuming no liability.

Mariners of ocean tugs and barges, as well as coastwise vessels not picking up a Boston Pilot, are requested to call "KCB-445" on channel 16 (156.80 MHz.) or channel 10 (156.50 MHz.) upon arrival in a reporting zone within a radius of 5 miles of Boston Lightship giving the following information: (a) type of vessel (whether self-propelled or towing). (b) if towing vessel, whether on hawser, alongside or pushing, (c) destination, (d) deep draft, (e) and radio frequency that they may be contacted on during the transit of the harbor. It is also requested that mariners again check in with "KCB-445" when their transit is completed and the vessel is moored or anchored.

Prior to departure, it is requested that mariners call "KCB-445" on channel 16 or channel 10 giving their estimated time of departure, where bound (whether by Narrows or North Channel), the radio frequency that the transiting vessel will guard, and again a call when leaving the reporting zone around Boston Lightship.

The dispatcher at "KCB-445" will be available to disseminate advisory information that he may have on hand concerning vessel movements in Boston Harbor and Approaches and assist the incoming or outgoing mariner. This service will be maintained 24 hours a day. However, Boston Tow Boat Company volunteers its services and those of its employees, agents and servants without assuming any liability, but working for the best interests of safety within the port and its approaches.

It is also requested that towing vessels with tows operating within the harbor report their intentions to the dispatcher, so that he may pass on this information to incoming or outgoing vessels that might meet said tows in close quarters.

In the event mariners are unable to contact "KCB-445" on channels 16 or 10 they are requested to pass on the same information to the Boston Pilot Boat on station who, in turn, will relay the information to the dispatcher at "KCB-445".

The cooperation of all mariners transiting the Boston Harbor area is requested in the interest of safe navigation.

PILOTAGE

Pilotage is compulsory for all foreign vessels, with few exceptions, and for U.S. vessels under register in foreign trade. Pilotage is optional for coastwise vessels who have on board a pilot licensed by the Federal government for these waters. The pilot boats meet vessels within sight of the Boston Lightship. During winter months, with a northwesterly wind, the pilot boats may meet vessels to the northwestward of Boston Approach Lighted Buoy "BG", seeking shelter under the Nahant Head. The pilot boats often land or pick up pilots at the town wharf at Nahant Harbor.

The pilot boats, the 70-foot BOSTON PILOT and the 52-foot THOMAS KNOX, have black hulls with the PILOT in black letters on either side of the white superstructure. Both are equipped with radar. Vessels are requested to give a 4-hour advance notice of their time of arrival. The pilot boats maintain a 24-hour radio watch on VHF-FM channel 16 (156.80 MHz.) and also maintain a radio watch on VHF-FM channel 11 (156.55 MHz.) from 0700 to 1800. A pilot boat being on its station and displaying the signals required by law constitutes an offer of pilotage service. Such compliance will entitle the pilot to the regular fee for pilotage from vessels otherwise liable therefor. A vessel under 350 tons register bound into the port of Boston declining the services of a pilot is liable to one-half the pilotage fees. A vessel under 350 tons register bound out of the port of Boston is not liable for pilotage unless such services are requested.

Pilots for Weymouth and Quincy are obtained from the Boston Pilot boat. Pilots can be notified by radio, telegraph or by radiotelephone through the Boston Marine Operator.

TOWAGE

Tugs up to 3,000 hp. are available at Boston. The tugs maintain radio communications on VHF-FM channel 10 (156.50 MHz.). Inbound vessels are usually met in the vicinity of anchorage areas 1 or 2. Arrangements for tugs are usually made in advance through the ship's agents. Fireboats are also available; the call for the fireboat is five prolonged blasts of the ship's whistle.

QUARANTINE

Quarantine, immigration and agriculture quarantine officials are stationed in Boston. Vessels subject to inspection generally make arrangements in advance through the ship's agents; officials usually board vessels at their berths.

Quarantine is enforced in accordance with regulations of the U.S. Public Health Service. Quarantine anchorages for Boston Harbor are on the north side of President Roads and on Bird Island Flats.

COAST GUARD

The Captain of the Port and the Marine Inspection Office are at the Boston Coast Guard Base. A vessel documentation office is in downtown Boston.

HARBOR REGULATIONS

There are many rules and regulations of the Commonwealth of Massachusetts and the city of Boston affecting the handling of petroleum products, rafting of lumber, speed of vessels, control of motorboats, pollution, disposal of refuse, handling of lines, movement of vessels as directed, anchorage areas, etc. It is recommended that the navigator obtain from the harbormaster copies of the rules affecting his particular interest.

The call for the harbormaster or police vessel is three short and one long blast of the whistle.

WHARVES

The Port of Boston has more than 150 piers and wharves with more than 30 miles of berthing space, most of which are located on the main channel at East Boston, Charlestown, Mystic River, South Boston, and on Chelsea River and Chelsea waterfront.

The piers and wharves generally are of open-pile concrete deck construction, extending from stone or timber bulkheads with solid fill. Only the deep-draft facilities are described; the other active facilities in the port are used as repair berths, and by government vessels, fishing vessels, small craft and barges. All of the facilities have direct highway connections, and most have railroad connections.

Six of the seven large general cargo terminals are owned or leased by the Massachusetts Port Authority. Containerized cargo is handled at the Castle Island Terminal and at the Boston Army Base Terminal. Most of the deep-water oil and bulk terminals are on the Chelsea River and Mystic River.

FACILITIES

South Boston

Castle Island Terminal - receipt and shipment of container cargo, general cargo, receipt of lumber, petroleum products, bulk cement and automobiles, shipment of scrap metal.

White Fuel Corporation Tanker Wharf - receipt and shipment of petroleum products, receipt of molasses and bunkering vessels.

Army Base Terminal - receipt and shipment of general and container cargo.

Commonwealth Pier 6 - receipt and shipment of general cargo, passengers receipt of tallow and animal fats.

East Boston

East Boston Terminal, Piers 1, 3, and 4 - Pier 1: receipt and shipment of general cargo, receipt of liquid latex and vegetable oils; Pier 3: receipt and shipment of general cargo, receipt of liquid latex; Pier 4: receipt and shipment of general cargo, receipt of liquid latex.

Charlestown

Hoosac Pier - receipt and shipment of general cargo, receipt of steel and plywood.

Mystic Pier 1 - receipt and shipment of general cargo, receipt of lumber and steel products.

Mystic River, south blank

U.S. Gypsum Co. Wharf - receipt of gypsum rock from self-unloading vessels.

The John F. Moran Docks (Boston-Mystic Public Container Wharf)

Mystic Wharf - shipment of scrap metals, receipt of steel products.

Pier 51 - receipt and shipment of general cargo.

Revere Sugar Refinery Wharf - receipt of raw sugar

American Sugar Company Wharf - receipt of raw sugar and fuel oil.

Mystic River, north bank

Union Carbide West Chemical Wharf - receipt of chemicals, petrochemicals and solvents.

Prolerized New England Scrap Metal Wharf - shipment of scrap metals.

Prolerized New England Sulphur Wharf - receipt of liquid sulphur.

Humble Oil Everett Terminal Wharf - receipt and shipment of petroleum products, receipt of asphalt, bunkering vessels.

Marquette Cement Wharf - receipt of cement by self-unloading vessels.

Chelsea River, north bank

Metropolitan Petroleum Wharf - receipt and shipment of petroleum products, bunkering vessels.

Eastern Minerals Wharf - receipt of bulk salt.

Texaco Pier - receipt of petroleum products.

Jenny Wharf - receipt of petroleum products.

American Oil Co. Wharf - receipt and shipment of petroleum products.

Gulf Oil Tanker Wharf - receipt and shipment of petroleum products, bunkering small vessels.

Chelsea River, south bank

Union Oil Co. Pier - receipt and shipment of petroleum products.

Sunoco Pier - receipt and shipment of petroleum products.

Atlantic-Richfield Co. Pier - receipt and shipment of petroleum products, bunkering small vessels.

State Fuel Co. Wharf - receipt and shipment of petroleum products.

SUPPLIES

Provisions and marine supplies of all kinds are available in the port of Boston. All grades of heavy marine bunker fuel, lubricants and diesel fuel can be obtained. Vessels or may be be serviced by barges at anchor or at loading berths.

REPAIRS

The port of Boston has excellent facilities for making all types of hull and engine repairs to vessels of all sizes. Several of these firms operate waterfront facilities for the construction, repair and conversion of oceangoing vessels. There are several drydocks and marine railways available in the port. The largest nongovernment repair facilities are located in East Boston and in Quincy. The East Boston yard has two floating drydocks, the largest of which has a lifting capacity of 18,000 tons,

overall length of 622 feet, and a maximum clear width of 93 feet; a smaller graving dock at the yard has a length of 256 feet, width of 46 feet at the entrance, and a depth of 16-1/2 feet over the keel blocks. The yard has several cranes with capacities up to 25 tons. The Quincy yard has three graving docks and two floating drydocks. The largest graving dock has a length of 938 feet, width of 147 feet at the entrance and a depth of 18 feet over the keel blocks; the largest length of 354 feet, and a maximum clear width of 85-1/2 feet. Two overhead traveling bridge cranes, each smaller cranes are available at the yard. The Quincy yard also builds very large vessels.

SHIP CHANNELS

Boston North Channel

Boston North Channel leads from Broad Sound to President Roads from the northeastward. It is the principal entrance to Boston Harbor. A federal project provides for a channel 1,500 feet wide dredged to 40 feet in the eastern 900 feet and 35 feet in the western 600 feet. The channel is well marked by lighted buoys.

Finns Ledge, covered 25 feet, lies on the western side of the entrance to Boston North Channel. The ledge, marked by a lighted bell buoy, is at the outer end of shoal ground covered less than 36 feet. The shoal ground extends about 2 miles northeastward from Deer Island. Careful navigation is required in the channel entrance, especially when incoming and outgoing vessels meet.

Boston South Channel

Boston South Channel leads from Broad Sound in a southwesterly and westerly direction to President Roads. The channel has a controlling depth of about 28 feet and is marked by unlighted buoys.

Pilots of deep-draft vessels use the North Channel most of the time. The South Channel is rarely, if ever, used because deep-draft vessels have a tendency to feel the bottom causing steering difficult.

The Narrows

The Narrows is the channel that leads into President Roads from the southeastward between Boston Light and Lovell Island on the northeast, and Point Allerton, Georges Island and Gallops Island on the southwest. Depths of about 25 feet can be carried in the well-marked channel. Shoals with depths of 18 to 23 feet are in the southeastern approach to the Narrows.

Because of the strong currents and sharp turns, it is necessary to conn a ship by eye through the approaches and in The Narrows channel. The navigator must take precautions to prevent being set off course by crosscurrents sweeping in or out of Black Rock Channel and the channel between Gallops Island and Georges Island.

Hypocrite Channel

Hypocrite Channel is a natural channel leading between Green Island on the north and Little Calf Island on the south. The greatest draft that can be carried through it to Boston South Channel is about 18 feet. The channel has several unmarked dangers and is not recommended for strangers or for larger vessels.

President Roads

President Roads, between Deer Island and Governors Island Flats, has depths of 30 to 60 feet. Its northern part is used as a quarantine anchorage.

Reserved Channel

Reserved Channel, 0.5 mile northwestward of Castle Island, is a dredged unmarked channel which leads westward from the Boston main channel for about a mile to near a drawbridge. In 1967 the channel had a controlling depth of 32 feet. There are modern and extensive freight terminals on the north and south sides of the channel.

Fort Point Channel

Fort Point Channel separates Boston proper from South Boston. A dredged channel with a controlling depth of 21 feet in 1959 leads from the entrance to Dorchester Avenue Bridge, a distance of 0.7 mile. The water of the channel above the easterly side of Dorchester Avenue Bridge have been declared nonnavigable.

Vessels bound into Fort Point Channel require the assistance of tugs.

Charles River

Charles River, on the western side of the harbor between Boston proper and Charlestown, is the approach by water to Cambridge and Watertown. The entrance of the river to the first bridge has been dredged for its full width to a depth of 35 feet. The controlling depth is about 15 feet from this bridge to Charles River Dam, about 1 mile above the entrance.

The lock in the Charles River is 350 feet long between gates, with a clear width of 45 feet, and has a depth of 17 feet at low water on the lower sill. The upper sill has 21 feet over it at the level of the river above dam.

The river above the dam is used by many yachts and small craft. There are four yacht clubs on the river, some college sailing and rowing clubs, and two large marinas, one above and one below the dam and two public float landings above the dam.

Below the dam Charles River is crossed by several fixed and drawbridges. The Charlestown Bridge has fixed span with a clearance of 23 feet. The highway bridge about 200 yards upstream has a fixed span with a clearance of 48 feet due to an overhead pipeline being suspended from below the bridge. The four Boston and Maine Railroad bridges have bascule spans raised as a unit with a clearance of 3 feet. The two bascule bridges at the dam have a clearance of 5 feet.

Little Mystic Channel

Little Mystic Channel is a slip about 0.6 mile long just northward of the Navy Yard at Charlestown. Midchannel depths range from 31 feet at the entrance to 17 feet 600 yards westward of the bridge. The fixed highway bridge over the channel has a clearance of 100 feet. The horizontal clearance in the channel is limited to 75 feet due to the remains of the approaches of the former Chelsea Street Bridge immediately downstream.

Chelsea River

Chelsea River, emptying into Boston Harbor from eastward between East Boston and Chelsea, is the approach to important wharves and facilities, and to the city of Revere at the head, 2.6 miles above the entrance.

There are dredges depths of 27 to 30 feet in Chelsea River from the mouth to a point about 1 mile upstream from the Chelsea Street Bridge.

Two drawbridges cross the river. The Andrew P. McArdle Bridge, just above the mouth, has a bascule span with a clearance of 21 feet, and the Chelsea Street Bridge, 0.8 mile upstream, has a bascule span with a clearance of 9 feet.

Chelsea River has a heavy traffic of deep-draft oil tankers. The tankers berth at the oil company terminals and storage areas on both banks of the river.

Mystic River

Mystic River, which empties into Boston Harbor opposite Chelsea River, is the approach by water to the towns of Medford and Malden.

In 1969, the controlling depths in the dredged channel were 32 feet from the Mystic River-Tobin Memorial Bridge to within 500 yards of

the Malden Bridge, thence 27 feet to within 100 yards of the Malden Bridge, thence 14 feet to about 800 feet above the bridge.

Two special small vessel anchorages are on either side of the north end of the Mystic River-Tobin Memorial Bridge.

The mouth of the Mystic River is crossed by the Mystic River-Tobin Memorial Bridge, a high-level fixed highway bridge, with a clearance of 135 feet. The Malden Bridges, 1.2 miles above the mouth, have bascule spans with a clearance of 12 feet. The Boston and Maine railroad bridge, 1.5 miles above the mouth, has a swing span with no clearance at high water.

Island End River

Island End River is a tributary of the Mystic River entering from northward, 0.5 mile above the entrance. A large wharf is at the western side of the entrance with a channel privately dredged to 30 feet leading to it. The wharf, which is about 350 yards long, has a least depth alongside of about 22 feet to within 100 yards of its northerly end. A smaller wharf about 150 yards above the large wharf has a least depth of 2 feet. Above the large wharf, the river gradually shoals from 4 to less than 2 feet at its head. There is considerable business at the wharves near the entrance, principally vessels carrying petroleum products and cement. A rocky shoal on the east side of the entrance, and the current of Mystic River running across the entrance, make navigation difficult for large vessels. A tug usually is employed to assist such vessels.

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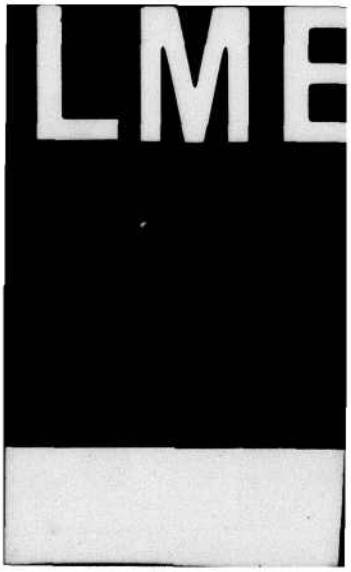
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